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THE REDUCTION OF INTRACRANIAL PRESSURE IN CEREBRAL INJURY BY THE INTRAVENOUS USE OF HYPERTONIC SUCROSE SOLUTION*

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IN AN address, 15 years ago, before the Chicago Surgical Society, one of the authors (H. J.[1]) stressed the importance of intracranial pressure in skull fractures with cerebral injury. It was shown that intracranial pressure was due to three factors: Increase in cerebrospinal fluid content of the ventriculo-subarachnoid system, produced by increased secretion and decreased absorption of cerebrospinal fluid; edema of the brain as a response to cerebral injury; and congestion and hemorrhage of cerebral blood vessels. It was further demonstrated that when six hours or more were allowed to elapse after injury, shock subsided and hemorrhage was arrested by the increased intracranial pressure in all but the most severe cases where large blood vessels were ruptured. In addition, data collected from a large series of clinical cases showed that intracranial pressure was lowered to normal by the removal through spinal drainage of excess cerebrospinal fluid mixed with blood constituents. This reduction could be maintained by repeated lumbar puncture for three to four days at which time the increased pressure had sufficiently subsided to allow normal circulation of the cerebrospinal fluid to take place, and thus the usual secondary symptoms of intracranial pressure, *i.e.*, the slow pulse, stertorous respiration, increase in blood pressure, and edema of the eyegrounds, did not supervene, and the stupor or irritability of the patient was relieved in most cases. The usual treatment advocated at that time was subtemporal decompression which did not relieve intracranial pressure or lower the mortality rate.

Not enough attention has been given to the withdrawal of blood from the subarachnoid spaces in cerebral injury. That the effusion of blood in the subarachnoid space is highly irritating, causing pia-arachnoiditis, has been known for years. Recently Weed[2] has shown that blood serum in the cerebrospinal fluid retards absorption of this fluid, causing it to collect in greater

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amounts in the subarachnoid system. Parker and Lehman,[3] in experiments on dogs with lacerations of the brain, have found that the pressure of the cerebrospinal fluid varies directly with the amount of blood that escapes into the subarachnoid space and not with the amount of bleeding into the cerebrum or enlargement of the brain due to traumatic edema. The most irritating substance is the serum protein of the blood. It is this fluid constituent of the blood that can be withdrawn easily and safely by lumbar drainage of spinal fluid, which procedure also takes off the excess of spinal fluid directly without disturbing the fluid equilibrium of all of the other tissues of the body. We felt that the edema of the brain was a physiologic response to injury and that a moderate amount of edema was a help toward healing of brain tissue and should not be too strenuously combated. However, in the few cases of diffuse edema of the brain, where lumbar drainage alone was not sufficiently effective in reducing intracranial pressure, other measures might be used to reduce the edema.

For this purpose Weed and McKibben[4] had advocated the use of hypertonic solutions intravenously. Sodium chloride, 20 to 30 per cent in strength, was first employed but it was soon found to be toxic, caused crenation of red blood cells, and was diffused through the blood vessel wall and deposited in the brain, where it produced a secondary edema and a secondary rise in intracranial pressure, thus defeating the very purpose for which it was employed. Fifty per cent hypertonic glucose was, therefore, substituted for the saline and has been widely employed for many years. In 1932, a series of cases were reported[5] in which hypertonic glucose solution was employed which demonstrated a secondary rise in intracranial pressure and toxicity from its use, which was similar to that resulting from sodium chloride but less in severity. Others, working on normal and pathologic cases, corroborated these findings.

Recently Bullock and his coworkers,[6] recognizing the defects of the saline and glucose solutions, have been experimenting on dogs with 50 per cent hypertonic sucrose solution, and have shown that 100 to 500 cc. may be injected intravenously at a rate of 5 cc. per minute with a reduction of 25 to 100 per cent or more in intracranial pressure as recorded by the water manometer attached to the cisternal puncture needle. There was no secondary rise in intracranial pressure, as had been the case with the saline and glucose solutions, and no toxicity. In fact, the sucrose was mostly excreted by the kidneys within five hours with a profound diuresis. Unlike glucose, the molecule of sucrose was not utilized by the blood and not diffused into the tissues. Also, this large molecule, a disaccharide, did not penetrate the blood-cerebral barrier and appear in the cerebrospinal fluid or brain. It seemed, therefore, an ideal substance for the reduction of fluid from all the tissues of the body including the brain and meninges.

Masserman,[7] working on normal humans, found that 50 per cent hypertonic sucrose in amounts of 300 to 500 cc., given intravenously, reduced

intracranial pressure about 37 per cent for a period of two and one-half to five hours and that the diuresis so produced amounted to about four times the amount of sucrose solution injected. The patients complained of thirst, malaise and muscle pain, and showed a moderate leukocytosis but were otherwise not adversely affected. He states there was no crenation of blood cells and no secondary reaction. It would seem, from the observations by Bullock on animals and Masserman on normal humans, that sucrose was nontoxic and, therefore, a better solution for intravenous use than either saline or glucose. As no reports had been made on patients with cerebral injury, we undertook this research about one year ago on my cases at the Cook County Hospital and in private practice. The routine injection has been the same as with hypertonic saline and glucose solution after the shock has subsided.

Stuporous or comatose patients were selected that showed signs of contusion of the brain (increased intracranial pressure and bloody fluid), usually with fissured fracture of the skull. Patients with extradural or subdural hemorrhages, convulsions or paralysis, depressed or compound comminuted skull fracture were ruled out. Also, patients were not selected who exhibited active bleeding and loss of cerebrospinal fluid from the ears or nose. With these limitations, even in so large a hospital as Cook County, the number available for continuous observation over a period of 24 to 48 hours was small.

Technic.—The patients are placed in the lateral position with the head on a level with the spine. Usually, in restless patients, local procaine anesthesia is used for the introduction of the spinal needle. The Queckenstedt test is applied to determine the patency of the cerebrospinal system. Readings are made for a few minutes with a No. 18 gauge needle to evaluate spinal pressure variations without withdrawing more than a drop or two of spinal fluid to determine the presence of blood and a free tap. The hypertonic solution put out in ampoules by Eli Lilly & Company or prepared in the hospital from commercial cane sugar is then injected slowly into the median basilic vein of the forearm in amounts of 100, 200, 300 and 400 cc. Readings are then repeated, with the spinal needle attached to the mercury manometer, at varying intervals up to 48 hours.

Results.—In eight severely traumatized cases of brain injury the average reduction in pressure was 50 per cent, the least reduction was 16 and the greatest 66 per cent. The reduction is maintained for six hours and in some cases for as long as 24 hours. Two hundred to 300 cc. of 50 per cent solution are necessary in most instances to produce these reductions because sucrose has only one-half the osmotic pressure effect as compared to glucose.

In three severe cases there was no reduction; one of these was in extremis. In two cases there was an increase in pressure. One hundred cc. caused a slight increase in pressure after four hours from 34 to 36 Mm. Hg. In the other case, 400 cc. caused an increase from 11 to 16 Mm. Hg. after two hours. We were unable to account for these exceptions. In both of these cases, a reduction was afterward obtained by the withdrawal of

TABLE I

RÉSUMÉ OF CLINICAL OBSERVATIONS IN 13 CASES

No.	Case	Injury Produced by	Symptoms	Sucrose Intravenously 50%	Cerebrospinal Fluid Pressure (Mm. Hg.)	Spinal Fluid	Amount Withdrawn	Blood Pressure	Pulse	Results
1	L. P., age 18, admitted one hour after being shot in the head (male).	32 cal. revolver	Bullet hole in rt. subtemporal region. Listlessness; rigid neck.	100 cc. 30 min. later 2 hrs. later 3½hrs. later	20 24 20 10	Bloody Bloody Yellow Yellow	15 cc. before sucrose given	112/80 120/84	100 120 108 72	Complete recovery (12 days)
2	W. K., age 45, entered hospital two and one-half days after injury (male).	Beaten by bandits	Jacksonian convulsions of left face and arm, rigid neck, eyes deviating to the left, semicomatose.	100 cc. 30 min. later 1 hr. later 2 hrs. later	12 12 12 0 (agonal)	Bloody Bloody Bloody None		148/90	110 126	Died (three days)
3	T. T., age 28, brought in intoxicated, comatose and bleeding from head wounds (male).	Tavern brawl	12 cm. laceration over right parietal region, comatose, shock.	100 cc. 15 min. later 30 min. later 35 min. later	18 18 18 8	Bloody Bloody Clear Clear	 18 cc 	140/60 144/76 	108 80 108 	Recovery delayed by an infected scald —23 days
4	J. D., age 50, brought in unconscious after falling down stairway, bleeding about head (male).	Fall down stairway	Blood and spinal fluid running from right ear; coma-involuntary; laceration over right parietal region.	100 cc. 30 min. later 2 hrs. later 48 hrs. later 48 hrs. later	18 21 18 18 7	Bloody Bloody Bloody Bloody Bloody	30 cc before sucrose given 16 cc.	120/76 130/70 130/76 126/76 114/78	76 76 78 	Recovery (16 days)
5	J. B., age 50, brought in several hrs. after extensive injuries (male).	Hit by auto	Left side of head deeply traumatized, nose bleed, headache, fractured mandible, right radius, *etc.* Babinsky ++	100 cc. 20 hrs. later 20 hrs. later	28 12 13 5	Bloody Bloody Bloody Bloody	70 cc. 70 cc.	139/93 200/80 170/80 135/60 180/90 210/95	84 110 110 	Died (two days)
6	C. B., age 48, brought to hospital eight hours after being injured severely (female).	Run over by auto	Coma, lacerations over head, trauma to entire body.	100 cc. 45 min. later 1 hr. later 1 hr. later	19 16 8 5	Bloody Bloody Bloody Bloody	 9 cc.	116/68 	120 90	Recovery with traumatic psychosis (47 days)

7	L. P., age 25, admitted two hours after receiving injuries (female).	Beaten with hammer	Intoxicated, contusions over head and neck, paralysis of lower extremities, vomiting.	100 cc. 1 hr. later	15 5	Clear Clear	None	130/70	94 90	Recovery (five days)
8	W. A., age 17, admitted immediately after injury (male).	Fall from bicycle	Coma, hemorrhage from right ear, epistaxis, vomiting, irregular pulse.	100 cc. 1 hr. later 1 hr. later 1 hr. later	16 11 10 2	Clear Clear Clear	10 cc.	118/68 110/60 110/60	62 76 80	Recovery (20 days)
9	E. M., age 26, brought in by police who found patient in alley (male).	Drunken brawl	Coma, scalp lacerations, intoxication.	100 cc. 1 hr. later 2 hrs. later 72 hrs. later	14 6 5 5	Bloody Bloody Bloody Bloody	None	130/78 136/80	82 84 88 80	Recovery (15 days)
10	L. A., age 28, brought in shortly after being shot (female).	32 cal. revolver	Rational, bullet wound upper left malar, hemorrhage from left ear.	300 cc. 3 hrs. later 24 hrs. later	28 14 13	Clear Clear Clear	None	112/72	76 88	Recovery (in hospital)
11	G. H., age 45, admitted two hours after being rendered unconscious (male).	Beaten by bandits	6 cm. laceration in right parietal region and a 3 cm. one in left, bleeding from mouth, trauma to head.	200 cc. 1 hr. later 1 hr. later	11 14 16	Clear Clear Clear	None	118/78 126/82	96 96 88	Recovery (in hospital)
12	W. P., age 60, admitted because patient was found wandering aimlessly about (male).	Fall upon street	Confused, depression over right temple region, pupils irregular, paralysis of seventh nerve, rigid neck.	300 cc. 3 hrs. later 4 hrs. later	26 20 16	Bloody Bloody Bloody	None	146/98 144/90	78 80 86	Improved (in hospital)
13	M. D., age 26, admitted soon after accident (female).	Auto accident	Coma Contusion over right temple. Fracture suspect.	100 cc. 2 hrs. later 4 hrs. later 4 hrs. later	34 38 36 16	Bloody Bloody Bloody Bloody	25 cc.	145/85 145/85	92 90	Improved (in hospital)

cerebrospinal fluid. A slight initial increase was noted in some of the cases when later there was a reduction. This is probably due to the temporary increase in blood volume and venous pressure. It is realized that this series of cases is small and we are continuing our research. The results obtained (Table I), however, seem adequate for the following conclusions.

Compared to glucose, the reduction in spinal pressure with the sucrose solution has been greater, in some cases up to three times that produced by glucose. Moreover, there has been no secondary increase in cerebrospinal pressure except in two instances, and no toxicity, and the patients have been relieved of headache and restlessness with a few exceptions. However, many patients complain of thirst and the tissues are depleted of water and shock is prolonged. To determine whether disturbances in cerebral circulation and tissue permeabilities in accident cases might allow sucrose to break through the encephalic barrier, where such might not be found in normal cases, determinations of sugar content of the cerebrospinal fluid were made before and after the administration of hypertonic sucrose solution. No increase in sugar content of cerebrospinal fluid has as yet been noted. Compared to lumbar drainage, the following may be said: Where the reduction in intracranial pressure is from 28 to 13 Mm. Hg. by the introduction of 300 cc. of 50 per cent sucrose solution, the pressure can be further reduced to normal by the removal of 10 to 20 cc. of bloody spinal fluid. Moreover, the tissues of the body are not drained of their fluids as with sucrose and no thirst is produced. The alleviation of thirst by the intake of water would, of course, nullify the effect of the sucrose. Tissue fluids are necessary in states of general surgical shock and hemorrhage, which are practically always present in marked degree in all cases of brain injury and skull fracture. Also some of the irritating blood constituents present in the cerebrospinal system are removed by spinal drainage but this remains to produce clotting and irritation where hypertonic solutions are used.

In our opinion, hypertonic sucrose solution may be used as an adjunct in those cases of severe edema of the brain where spinal drainage is not successful, and in cases of multiple fracture of the pelvis or extremities where spinal drainage may be difficult or impossible. Here it may become the method of choice. In cases where spinal drainage is not productive of a marked fall in pressure, the edema of the brain may be pronounced and the use of hypertonic sucrose may be of greater benefit.

In connection with the use of sucrose, where the effect is produced by the rapid elimination of fluid from the body through the urinary tract, the question arises relative to the employment of other methods of dehydration to produce the same results. Such methods have already been in use and advocated for many years, the oldest probably being the use of magnesium sulphate by mouth or rectal retention enema or by hypodermic injection. This chemical has a marked hydrogogue effect upon the intestines and by active peristalsis relieves the bowels of a large amount of fluid and stool content.

The water is abstracted from the blood which in turn takes it from the tissues and produces similar effects to that of sucrose.

A more comparable effect is that obtained by the xanthine or mercurial preparations. It has been a matter of common knowledge for many years that caffeine produces a marked diuresis and this effect, coupled with the action of caffeine upon the brain, in relieving it of venous stasis and of subsequent headache, has prompted its use in cranial injuries. Denker[8] has shown that with the injection of five grains of caffeine sodiobenzoate there is a 36 per cent drop in cerebrospinal fluid pressure within two minutes which returns to normal in 37 minutes. Fay[9] has attained similar results by limiting the intake of fluids, although he warns against dehydration in those cases complicated by hemorrhage or shock. The mercurials, novasural, salyrgan, and mercupurin, by their direct action on the kidneys, also cause a marked diuresis, similar to that effected by sucrose. Thus we see that the withdrawal of fluid from the tissues of the body may be brought about by other measures less difficult, less expensive and less time consuming. Christian[10] said in this connection: "Often do I have occasion to decry unnecessary intravenous injections in the treatment carried out by many of the practitioners of today. The dramatic, too often, influences their procedure. Unfortunately on occasions they set the stage for the drama of death by intravenous injections."

CONCLUSIONS

In two-thirds of the cases of cranial injury studied, sucrose reduces intracranial pressure by about 50 per cent with the intravenous use of 50 per cent solutions in amounts of 200 to 300 cc. given at a rate of 5 cc. per minute. It acts by withdrawing water from all the body tissues into the blood which, in turn, throws off both fluid and sucrose through the kidneys by an active diuresis. Similar withdrawal of fluid may be obtained with hydrogogue cathartics, e.g., xanthine or mercurial preparations and decreased water intake.

Hypertonic sucrose solution will find its best use in those cases where edema of the brain is pronounced and where spinal drainage is difficult or impossible to perform.

It still seems to be more logical to reduce intracranial pressure to normal in other cases by direct removal of the increased fluid, and irritating blood constituents from the subarachnoid system alone by lumbar puncture drainage in states of shock and hemorrhage where the tissue fluids are sadly needed and where general dehydration of the body may be serious if not fatal in its results.

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MORBIDITY FOLLOWING GOITER OPERATIONS*

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THE present communication considers the results in a series of cases operated upon for goiter with special reference to the postoperative morbidity. It covers a 14-year period ending January 1, 1935. The fact that such reports by those doing a fair amount of work in this field are only too rare in the literature as emphasized by Smith,[1] Parsons[2] and others, offers an excuse for the present report.

The Return Visits and Evaluation of Results.—Eight hundred and three patients constitute this series. Every one was seen and examined during a period of not less than six months up to 14 years postoperative. The results in all cases are based on the evidence obtained from a personal examination and not from a questionnaire sent to the patient.

This evidence was considered from a symptomatic, anatomic and economic point of view as occupational and social restitution, and a check on history and signs of stability—pulse—blood pressure—basal metabolic rate—weight—exophthalmic measurements and laryngoscopic examination. With an otherwise normal check up, a plus or minus 15 basal metabolic rate was allowed. Smith, in his series, allowed a plus or minus 20 basal metabolic rate. An anatomic cord impairment, though phonation be normal, a poor scar, the mere recurrence of thyroid hypertrophy in an otherwise normal patient placed the result in the unsatisfactory class.

Acute Fulminating Thyrotoxicosis—Thyroid Crises.—Toxic goiter left alone and untreated will kill. Two cases came under our observation in the final stages of acute crises. They ran a progressively downhill course and in spite of all medical treatment and ligations, both died. (Since the writing of this paper, we have had one case of acute preoperative crises recover.)

Kessel and Hyman[6] report 12 per cent mortality before operation could be attempted and four died of acute thyrotoxicosis shortly after admission to the hospital.

Postoperative Thyrotoxicosis—Thyroid Crises.—This complication is sudden in onset, of short duration—an overwhelming toxemia—and has no specific treatment. The excitable phase resembles cocaine poisoning. It is difficult to reconcile this complication with a single oversecretion theory when it very often occurs 24 to 36 hours following a most radical subtotal thyroidectomy. Up to this period it is conceivable that the tissue cells have enough hormone to carry on. Here is left a shaving of traumatized thy-

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roid tissue that has not a chance to function until recovery takes place, involving a period of time. Upon this theory of suppressed secretion, thyroid substance has been used in the treatment of this complication with some degree of success.[1, 7, 8, 9] This is based on the probability of a sugar starvation of the cells of the central nervous system, as in these crises sugar is found to be of value, as the blood sugar is found to be low,[11] and the fact that thyroid substance has been found to raise blood sugar.

This complication was encountered 30 times in this series: *27* times in the primary hyperthyroid group, three times in the toxic nodular group. This toxemia with its secondary cardiac failure was responsible for eight deaths (one in the toxic nodular group and seven in the Graves group). It proves to be the most frequent cause of mortality in the whole series. Pool and Garlock[12] reported *225* cases of toxic goiter in which *12* died and five survived this complication. Goetsch[5] reported this the most frequent cause of mortality in his series. Heyd,[13] on the other hand, in a series of 148 operations for toxic goiter, reported no mortality due to this complication.

In our mortality group, this complication resulted fatally in three cases following subtotal resection—in one case after a ligation of two superior vessel groups, in another following subtotal resection (all four vessel groups having been previously ligated); and finally in one following a subtotal resection (all four vessel groups and a lobectomy having previously been performed).

Recurrences.—"Will my goiter recur following operation?" is a frequent inquiry by the patient and is significant of the frequency of recurrences, which implies a preceding period of normal function or freedom from symptoms and an absence of a perceptible thyroid enlargement. Eighty-three per cent of our good results were symptom free three to eight months following operation. In my opinion, following an adequate operation, recurrence in the Graves type is proportional to and depends upon the careful supervision and mode of life for a two year postoperative period. Leaving an amount of thyroid tissue that is equal to one-fourth of a normal lobe on each side will prove adequate in most cases. A more radical procedure favors permanent hypothyroidism and laryngeal complications. I agree with most authors that the removal of enough gland to produce a mild and temporary hypothyroidism for a few months postoperative is an indication of an adequate operation. How long it will take for the remnant of gland to function to its fullest capacity and meet all the energy requirements of the individual is also a matter of experience. In the Graves type, the peak of recurrences existed during the two year postoperative period; and for this reason, I believe that to prevent recurrences the patient's mode of life must have its limitations during this period of delicate balance and especially so if the causes of the disease remain active. I feel that the word cure should be used with reservation since the disease may recur no matter what treatment is used.

In this series (including the Graves and nodular types), there were en-

countered in all 54 recurrences (5.6 per cent) for causes symptomatic and anatomic or both. Of these recurrences, 33 (3.4 per cent) happened to our patients primarily operated upon by us and the remainder (21) were from other clinics, operated upon for their recurrence in our clinic. In our series, recurrence was more common in the Graves type (4 per cent) as against 2.6 per cent in the nodular group. Other authors report from 5 to 14 per cent recurrences.[1, 12, 14, 15, 17, 18, 19, 20]

Recurrence was the third highest complication affecting our results and if the recurrences noted by us from the other clinics be included, it was the most frequent complication encountered.

In our Graves group eight cases from other clinics were reoperated upon by us, and of these, three died. Three of our recurrences were operated upon in other clinics. In our own 18 recurrences, there were ten excellent results and eight poor ones following further treatment. One recurrent case was cured by roentgenotherapy. The time of recurrence was from six months to ten years, the majority recurring in the first and second year postoperative. Lahey[16] states in his experience: "Recurrences happened from one to ten years following operation—that operation is the method of affecting a cure and that he has always found hyperplastic gland tissue at the secondary operation even though it can not be detected clinically."

In the nodular group there were 28 recurrences encountered. Recurrence happened from a one- to a 25-year period, but most often in the second and fourth years. Two cases had three recurrences. Two had two recurrences. Two recurred as the Graves type within a year, and two cases underwent complete involution (a disappearance of goiter and symptoms) under influence of rest and sedatives, which is occasionally the experience of others. Eleven in this group, either not reoperated or operated upon with a second recurrence, were classed as poor results.

There is a small group of patients among those given an excellent rating in the Graves type, who at intervals exhibit a temporary recurrence of symptoms such as palpitation, fatigue, tremor, nervousness and digestive disturbances. The course of this exacerbation is short and it disappears on elimination of the cause, usually over emotional and physical strain. Such disturbances challenge the absoluteness and permanency of a cure in Graves' disease, which may mean a thyroid gland limited and deficient in capacity or a nervous system that had been damaged by prolonged thyroidism indicating this disease may be primarily one of the involuntary nervous system, the goiter being only one phase.

Persistence of Signs and Symptoms.—In spite of an adequate operation, the persistence, to a variable degree, of signs and symptoms of thyrotoxicosis occurs. These patients never obtain complete recovery following adequate operation, as manifested by symptoms of rapid heart, asthenia and an exaggerated reaction to ordinary stimuli.

In this series there were 28 cases of persistent signs and symptoms following operation. Seven can be accounted for by incomplete operation (such

as ligations) over which we had no control. One was complicated by diabetes, which may have had some bearing on the final result. Five cases, all in our early experience, we felt had inadequate removal of thyroid tissue. The remaining 15 all had a long history of thyroidism and prolonged medication with iodine, but adequate removal of thyroid tissue. This group gave us a poor final result in 20 instances (excluding the diabetic and the seven instances of incomplete operation [ligations]).

Persistent Exophthalmos.—Persistent exophthalmos in patients otherwise cured happened in 42 instances (10.5 per cent) (other reports vary from 5 to 20 per cent.[13, 15]) Of these 42, 38 were bilateral and four unilateral. Two bilateral cases were complicated by double vision. In our group of satisfactory results this sign cleared in from six months to one year.

These 42 cases varied in degree of exophthalmos, which was the complication most often causing an unsatisfactory result in this group. One case persisted for four years before clearing. All others showed evidence of this complication at their last follow up.

Three cases not only persisted, but intensified following operation. Two of these developed double vision and one of the latter had intensive roentgenotherapy for months preceding thyroidectomy. Smith reports the development of exophthalmos three years following operation in a case having had no previous exophthalmos. Kessel and Hyman report that in a series of 60 operated cases, 11 had a postoperative increase in exophthalmos. Curtis[7] reports three cases.

Diminished cell oxidation to a point of cell asphyxia is a possibility in this persistent and intensified postoperative exophthalmos. Marine[21] has produced exophthalmos in young male rabbits by reducing oxidation to a minimum (total thyroidectomy and cyanide feeding) and attributes the exophthalmos partly to an overstimulation of the sympathetic centers in the subthalmic region as a result of asphyxiation and partly to overproduction of pituitary thyrotropic hormone. In this connection, I do not recall a report of any case developing exophthalmos following total thyroidectomy for heart disease.

Cardiac Involvement.—Cardiac involvement, excluding simple rate increase, occurred in 43 instances, the most frequent complication in this series. One of our deaths was due to cardiac failure. Goetsch reports four postoperative fatalities in his series and Heyd one in his series.

The statement is made that damaged heart is most often found associated with the nodular goiter type. In Graves' disease, the symptoms and not the goiter (which may or may not be present with the onset) drive the patient to early relief. In the nodular type, the patient has carried his goiter for many years and seeks relief for symptoms due to cardiac damage. In Parson's[2] series there was one-third more cardiac damage in the toxic nodular group as compared with the group of primary hyperplasia. Our experience is contrary to this. In our nodular group there were ten instances of cardiac involvement as compared with 33 in the Graves type. Paralleling

our experience, Lahey,[22] in his series of thyrocardiacs in 1929, reports cardiac involvement in 93 Graves cases as compared with 49 nodular cases.

The most frequent cardiac complication in both groups in our series was auricular fibrillation. This agrees with other observers.[22] In the toxic nodular group a temporary period of A. F. has occurred for three or four days postoperative in a few instances. Eighteen cases showed cardiac decompensation from a mild to an extreme degree.

Of the 43 thyrocardiacs, 13 (auricular fibrillation group) were eventually completely cleared of any cardiac involvement. Twenty showed improved hearts and ten either showed no improvement or increasing damage.

Parathyroid Tetany.—This complication occurred twice, once following subtotal thyroidectomy for Graves' disease and again following radical removal of the gland for carcinoma. In both instances, the complication was temporary and there was complete recovery.

Myxedema and Hypothyroidism.—There was one case of true postoperative myxedema: this patient had been poisoned by illuminating gas a few weeks before and had pneumonia following operation. Heyd reports three such cases in the Graves group following operation and one following Riedel's struma. Berford[19] reports four cases in a series of 890.

Signs such as fatigue, exhaustion, pallor, stiff and painful muscles, choky neck, a moderate fall in metabolism with or without a gain in weight occasionally follow goiter operations for several weeks and indicate hypothyroidism. Most authors report a gain of 15 to 25 pounds usually following operation for toxic goiter. A greater gain may occur in patients at the menopause. We have had eight such cases requiring temporary thyroid feeding. Smith reports six such cases in his series. With the regeneration of the thyroid remnant and the help of thyroid feeding, these cases usually clear.

A mild degree of temporary postoperative hypothyroidism is considered the ideal by Crile and others. To quote Crile:[23] "The removal of enough gland at operation to give a temporary and mild degree of postoperative hypothyroidism is the ideal to get a good result and that the gland left will hypertrophy enough to support the individual in a normal way."

This degree of precision is difficult to obtain inasmuch as the quality of thyroid tissue (or its energy capacity) differs in different individuals, so that the amount of thyroid left would be a normal energy producer in one case, too much in another, and insufficient in another. For practical purposes it has been our experience that to leave an amount of thyroid tissue on each side equal to one-fourth of a normal lobe gives a satisfactory result. In primary hyperthyroidism, both lobes should be resected even though one lobe appear normal in size. We have had recurrences in two instances by not following this procedure.

Pneumonia and Tracheitis.—Postoperative pneumonia occurred nine times with five deaths, an operative pneumonia incidence of 0.6 per cent and a mortality of .29 per cent. Both Pool[12] and Goetsch in their series report a low pneumonia incidence (1.7 and .02 per cent, respectively).

A tracheitis and a laryngitis of varying intensity occur commonly for the first day or two and may be mistaken for the hoarseness which is the result of nerve injury. It is undoubtedly due to the result of tracheal congestion incident to operative manipulation causing pressure. This may progress to a bronchitis and then to a bronchopneumonia. One such fatal pneumonia began with a tracheitis and followed a double superior ligation under local anesthesia in a patient age 30.

Embolism.—There were six cases with five deaths (a mortality of 0.5 per cent), two cerebral, three pulmonary and one of the right brachial artery. Goetsch attributes three fatalities in his series to embolism. His cases were long standing and had serious cardiac lesions. Four cases occurred in the Graves type and two in the nodular type of goiter. The case of the right brachial embolism happened on the seventh postoperative day. There was a complete return of circulation in this artery at the end of two months.

Tracheal Collapse.—There were five cases of deformities and partial tracheal collapse, but no case of true collapse due to erosion of cartilages as is reported. There was one case of deformed trachea from the pressure of a goiter, which gave trouble following operation in a child age 13. The trachea was narrowed by lateral pressure from a multiple nodular goiter. When the gland was resected, the deformed trachea, like a hard, partially collapsed, rubber tubing, failed to regain its usual shape. The airway was sufficient until the second day, when postoperative congestion of the mucous membrane and collection of mucus caused serious tracheal obstruction. Posterior extension of the head by allowing the patient's head to drop back over the back of a Gatch bed resulted in extension of the trachea and thereby a widening of its lumen. This relieved the situation until the congestion of the mucous membrane and outpouring of mucus subsided, thus avoiding a tracheotomy. There was no further trouble, though a roentgenogram several months later showed a narrowed trachea.

Collapse of the trachea in the manipulation of a pressure goiter during operation is a most serious situation and can be avoided by the method of intubation anesthesia. Should intubation anesthesia be found impossible or contraindicated, due to an extremely narrowed trachea and poor general condition of patient, local anesthesia is the only safe method. The latter has the additional advantage over the intratracheal method in that it does not conceal evidence of injury to the recurrent nerve by interfering with function of the vocal cords.

Should the trachea become jammed by the shifting of a pressure goiter during operation, and no results obtained by manipulation before deciding on a tracheotomy, one may try decompression by incising the goiter, which may be mostly fluid or semifluid degenerative tissue. One of our preoperative cases of partial substernal goiter suffered a complete collapse of the trachea while on the ward due to sudden shifting of head. There was asphyxia, though pulse was perceptible. Decompression was effected by incising a large degenerated cystic goiter.

Recurrent Laryngeal Nerve Injury.—Reports of injury to this nerve are meager and unsatisfactory. There were 18 instances (1.8 per cent) of disturbed phonation, respiration, or both, resulting from operation. Other reports vary from 1.7 to 50 per cent.[24, 25, 26, 27] Hysterical aphonia occurred four times, and is not to be confused with nerve injury. There were 13 instances in the nodular group as against five in the Graves. Pressure and nerve displacement are more prone to occur in the nodular type. No doubt nerve injuries are higher than reported due to the fact that no functional disturbance may be evident in the unilateral paresis, due to compensation of the other cord.

Four of our 18 cases occurred during operation, one as a result of momentary pressure in the delivery of a large substernal goiter under novocain (Heyd reports a similar occurrence), two as a result of controlling hemorrhage of the thyroid stump in one instance, and hemorrhage from the left inferior vessel group in another (the lower poles of the thyroid being the most vulnerable site), and finally as a result of trauma from too radical dissection of the gland from the posterior thyroid capsule. The other injuries occurred from a few hours to five weeks postoperative and were due to edema, hemorrhage, collateral infection (interstitial neuritis) or a cicatricial inclusion. In one instance there was evidence of injury appearing three weeks after the patient left the hospital. Late cases (from a few weeks to several months) are reported as due to cicatricial inclusion.

In all but two cases, a recent incomplete unilateral and a bilateral incomplete injury, there has been restoration of function. It is well known (Judd,[28] New[29]) that in most unilateral and in some incomplete bilateral cases restoration of function in whole or in part is due to compensatory function of the uninjured cord. In our 16 cases that cleared functionally ten showed anatomically an injured cord.

The occurrence of hemorrhage 12 hours postoperative was sufficient to cause a unilateral paresis in one case now rapidly improving. Pool reports a bilateral paralysis caused by a hemorrhage six hours postoperative in which tracheotomy was necessary; the patient, however, regained function of the cords. New, who has made many observations, states: "That functional disturbances occurring on the third or fourth postoperative day are due to hemorrhage or edema and usually clear in two weeks."

There were only two cases of preoperative nerve injury due to pressure of a goiter. There was no improvement of phonation following operation, as is reported by other observers.

Hemorrhage.—While careful and painstaking technic should be the answer to hemorrhage, many surgeons report this occasional complication (Haggard and Crutchfield,[18] 0.3 per cent; Buford,[19] 0.1 per cent; Heyd, 0.6 per cent; Smith, 1.3 per cent; Pool, 1.3 per cent. In our series the incidence was 0.8 per cent).

During operation, hemorrhage occurred three times due to the slipping of

a hemostat or ligature. If left on too long, a hemostat may pull away from a thin walled vein. We make it a rule to keep the field clear of hemostats and to use transfixion ligature for the larger vessels. One nodular goiter was a veritable mass of venous sinuses. There was difficulty, but no alarming loss of blood. Occasionally one encounters thyroid tissue, its vessels having the consistency of wet cardboard. Hemostats do not hold but actually sever the vessels. Suturing muscles to such thyroid tissue often solves the difficulty. Two such cases plus toxemia gave us mortalities.

Including three small venous hemorrhages of practically no consequence, we had five instances of secondary hemorrhage. Two were important as one resulted in pressure on one recurrent nerve and the other with toxemia gave us a fatality.

Drainage—Infection—Suture Material—Scars.—Every case in this series was drained, the drain usually being removed during the first 12 or 48 hours. Occasionally a wound drained serum or a small collection had to be evacuated within the first ten days postoperative, but we consider this morbidity of little consequence in comparison to a fatal mediastinal infection or a septicemia or paresis of an inferior laryngeal nerve resulting from pressure of hemorrhage in a neck closed without drainage. I have seen both of these latter complications following closure without drainage.

No matter how expert the technic, infection is always a potential morbidity. There have been 12 infections in this group but all were local and easily controlled due, in my opinion, to the fact that the wound at operation was closed with a drain. The worst local infection followed the use of silk technic. The latter was used in about 30 cases in our series, being discontinued following this infection and due to the fact that in several cases small pieces of silk made their way to the surface along the scar line for several months postoperative. While a good grade of catgut will give slightly more tissue reaction than silk, the difference, I believe, does not outweigh the possible morbidity of infection and the discharge of suture material following the silk technic.

There were eight unsatisfactory scars, due in our opinion to the following reasons:

(1) Making the site of incision lower than one and one-half inches above the superior border of manubrium with the head in extension. Below this one encounters the thicker skin of the chest where keloid reaction is frequent.

(2) By not protecting the skin edges from trauma of tissue forceps and retractors.

(3) By not carefully suturing the platysma muscles, which results in tension on skin edges and a widened scar.

Psychosis.—Psychosis not unusually complicates thyroid disturbances. There was an incidence of 0.7 per cent in this series. Crile,[14] in a series of 20,000 operations, reports 0.9 per cent in the toxic cases and 16 per cent in the simple goiters.

TABLE I

STATISTICAL RÉSUMÉ OF RESULTS AND MORBIDITY

Work Hypertrophies and Hyperplasias

	Morbidity				Mortality	Results			
		G.*	N.*	C.*		Satisfactory Note	Unsatisfactory	Poor	Economic Restoration
Cardiac impairment	43	33	10	13			30	Anat.	#
Exophthalmos—persistent	42	42					42	Sympt.	
Recurrence	33	22	11	14			19	Econ.	
Persistent P.O. thyroidism	28	28		8			20		
Postoperative toxemia	30	27	3	20	10[x]			8 Dead	
Postoperative pneumonia	4	1	3	4	5				
Recurrent nerve injury	18	1	17	6			12		
Embolism	1	1		1	5				
Myxedema	1	1					1		
Hypothroidism	8	6	2	8					
Hemorrhage	8	3	5		3		1		
Scars	8	1	7				8		
Psychosis	7	2	5				7		
Tracheal collapse	1		1	1					
Tetany	2	1	1 = Carcinoma						
Diabetes	3	2	1	[z]			1		
Primary cardiac failure	1	1			1				
Infections	12	5	7	12					
	250	177	73	89		662	141 →	(95	46)
	%25.	17.7	7.3		1.7-2.4	82.49	17.6	11.7	5.9

NOTE—Based on return of 803 patients—no return considered less than six months.

[z] Cleared from thyroid angle—diabetes improved.

[x] Two cases actually preoperative crises, death rate in spite of operation.

Residue signs and symptoms not severe enough to impair normal efficiency and capacity of the individual.

* G.—Graves.

* N.—Nodular.

* C.—Cleared.

The Complication of Diabetes Mellitus.—Most authors report an improvement in carbohydrate tolerance following subtotal thyroidectomy in diabetes mellitus complicated by hyperthyroidism. Checking hyperthyroidism in a diabetic is comparable to eradicating infection. The lowered metabolism improves the carbohydrate tolerance. There have been three such cases in this series, one Graves type and two of the nodular type—an incidence of 0.3 per cent. Coller and Huggins[30] report ten cases of hyperthyroidism among 1,150 diabetics. Hence this complication is rare in spite of the fact that mild and transient glycosuria associated with hyperthyroidism is often encountered and described in the literature (Tinker and Joyce[32]). In our series there were six cases of transient glycosuria, proved not to be true diabetes. According to Coller and Huggins, there is no parallelism of the height of the basal metabolism and the severity of the hyperglycemia.

In the experience of Fitz[33] the removal of a normal gland will not benefit the associated diabetes mellitus. There is also the experience of Wilder[34] of the Mayo Clinic.

Hyperthyroidism complicated by diabetes has been attended by a high mortality following operation. This has been reduced since the introduction of iodine and insulin plus stage surgery. I wish to emphasize the possible

onset of a diabetic coma following a thyroid operation on a supposedly non-diabetic patient. A mild and unrecognized diabetic may have a stormy course made possible by the severe transitory exacerbation of the diabetes following operation. I have experienced this following a single superior pole ligation in a patient with sugar free urine. Hence there is need of investigating the carbohydrate metabolism in all patients with hyperthyroidism and glycosuria or acetonemia, the latter of which may be associated with a thyroid toxemia. Tinker[32] refers to the insidious onset of diabetes in association with hyperthyroidism and the intensity of a careful postoperative urine examination. Tinker and Joyce report a 15 to 25 per cent incidence of glycosuria in their cases of hyperthyroidism.

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DISCUSSION.—DR. WM. BARCLAY PARSONS (New York) disagreed particularly on one point and that was with regard to the use of silk. He stated that at the Presbyterian Hospital, silk had been used exclusively for five years and that Doctor Whipple had referred to it on every possible occasion. The records there showed very definitely year by year improvement since discontinuing the use of catgut in thyroid surgery. A year ago, a new linen suture was tried out but the results were bad. In comparing the size used, it was definitely larger than the smallest size silk that had been employed. The size of the silk used is of extreme importance; it should be so fine that one breaks a good many ligatures as the ties are made. Other advantages of silk are that it is not only possible to tie a much nicer, neater knot with silk than with catgut, but the use of silk enables one to obtain better hemostasis, less tissue reaction, and a cleaner type of healing.

DR. J. ROGERS (New York) said that, whereas, the percentage of total unsatisfactory results given by Doctor McQuillan was 10 to 12 per cent, it is important to recognize the classification of that portion into those who do not get well and who will be a constant burden to one afterwards. In this group one would expect the failures to be in the group of old chronic hyperthyroids who had gone on for five or ten years before presenting themselves for surgical relief, as well as certain patients who have not had enough of the gland resected, and a third group that should be recognized and anticipated by a check up of the natural course of the disease. It is not possible to treat these patients adequately unless one goes into the question of etiology. All plus cases—all plus abnormalities—are closely related. As a rule, the hyperthyroid case begins with simple hypertrophy which bears every evidence of being a compensatory phenomenon to satisfy the needs of the body for iodized thyroid product. This is quite evident in cases where there is a lack of iodine in the food. The circumstances in the environment accompanying hyperthyroidism are always those that demand active nutrition; namely, lack of sleep, worry, fatigue, anxiety in the growing organism, all of which naturally require much activity on the part of the thyroid, which has much to do with oxidation in every organ and tissue. Compensatory hypertrophy should fol-

low. Though it is not known what mechanism it is that produces this multiplication of all the elements of the gland, some abnormality in this process produces cysts, single or multiple, in the gland. If excessive strain continues, the simple hypothyroidism, without symptoms, changes gradually until there is a mixed hypo- and hyper- stage so that the pulse is irregularly, rather than constantly, rapid. This occurs in adenoma as well as in simple hypertrophy. If this strain on nutrition continues still longer, then the condition becomes frank hyperthyroidism. If the condition develops without preliminary hypertrophy of the gland, then it is reasonable to assume that there is some defect in the organism which fails to produce that compensatory enlargement. If that small gland—and the very small glands are the worst—is resected in a standard or subtotal manner, a bad result known as persistent hyperthyroidism is very likely to occur, quite a number of which type of case the speaker has seen. It is best to avoid reducing the size of these small glands too much. They should be left at least about as large as the usual normal size. If the size is reduced in order to cut off excessive secretion, and if the vessels in the center of the gland are tied and the blood supply cut off, there is no doubt that that gland is inactive. To recognize the thyroid that will give bad results is to consider the very small gland.

The condition of hyperthyroidism, in Doctor Rogers' opinion, should not be called pure toxemia, for it has more the appearance of acute starvation of the nervous system. In acute toxemia, the recognized treatment that does the most good seems to be glucose. The thyroid has a great deal to do with increasing glucose in the circulation and presumably has a good deal to do with its absorption by the nervous system. In these postoperative cases Doctor Rogers has employed a thyroid extract known commercially as "Thyroid Residue," one cubic centimeter being injected intravenously every two hours for a pulse rate of 160. It is noticeable in this toxemia that this does not excite but lowers the pulse rate and affects nervous excitability considerably better than morphine. So that it looks as though it were a starvation phenomenon, the primary fault being a weak thyroid that cannot fulfill its function but overacts in the attempt to help the nervous system. Operative procedure seems to be a rather clumsy treatment, but it is the best we have to offer at the present time.

Dr. Charles Gordon Heyd (New York) said that Doctor McQuillan's report not only represented an analysis of the end-results in 1,000 cases operated upon for goiter, but also indicated the remarkable change that had occurred in the therapy of thyroid disease during the last 15 years. There were, in all, 1,000 cases and 1,400 operations. The earlier cases of this period were in the days of multiple operations and before preoperative treatment was rationalized and rendered so effective by the proper administration of iodine.

On one occasion, Doctor Heyd made the statement that more cases of acute, fulminating thyrotoxicosis died without surgery than from it. There is the idea in the minds of some physicians that extreme degrees of hyperthyroidism are not, per se, lethal. Doctor McQuillan's experience supports the thesis that there is a degree of intoxication in hyperthyroidism in which there is the imminent possibility of death. He had introduced a very interesting speculation that intense, postoperative thyrotoxicosis is due to an absence or inadequacy of thyroid secretion, or that it is fundamentally due to a suppressed secretion. This theory is contrary to the usually accepted idea and is interesting, if true.

An individual who has been subjected to long continued intense hyperthyroidism has the entire cell system of the body sensitized to any protein

derivatives. The presence of tissue serum in the operative field is sufficient to continue a thyroidism that has been interrupted by surgical intervention. It has been Doctor Heyd's experience that postoperative hyperthyroidism does not occur in the patients who have surgery for the hyperthyroidism due to adenoma, and that postoperative hyperthyroidism is peculiar and sequential to surgery performed on individuals with Graves' disease.

The belief is rather widely held among thyroid surgeons that the prevention of recurrent hyperthyroidism after operation is directly proportional to the amount of thyroid tissue that is left behind. The retention of an amount of thyroid tissue equivalent to two or three grams is sufficient to maintain hyperthyroidism or to reactivate a previous hyperthyroidism. In Doctor Heyd's opinion every patient with Graves' disease, after a thyroid resection, must have all points of focal infection eradicated. Chronic nasorespiratory infection, such as sinus disease or infected tonsils, initiates the vicious cycle that leads to the redevelopment of hyperthyroidism.

Doctor McQuillan's point as to the lack of wisdom in not safeguarding the patient from environmental circumstances after thyroid resection is well taken. To return an individual to the overstimulating effects of her previous life without advice and medical supervision is to invite a continuation or persistence of many of the symptoms for which the operation was undertaken.

The element of time—early or late operation—is a great factor in the success of thyroid surgery. The individual who has Graves' disease over a period of years may have a very remarkable symptomatic recovery and yet present throughout the remainder of her life stigmata and evidences of chronic cell degeneration. It is doubtful if long continued thyroidism, irrespective as to the degree of success that attends the operation, is not always associated with some far reaching sequelae. The appearance of periodic tachycardia, of easy fatigue, of changes in affectivity, may remain as an evidence of long continued thyroid intoxication.

The origin and development of exophthalmos, its persistence and its occasional development in individuals who have had a successful thyroid resection, with normal metabolism, are still inexplicable phenomena.

A fact of importance in the cardiac disability of hyperthyroid patients is in the remarkable age differences of the two groups of hyperthyroidism. The type of hyperthyroidism as seen in Graves' disease is different from the hyperthyroidism resulting from toxic adenoma. In Graves' disease there is a remarkable degree of hyperplasia, with reduction in colloid, and in the per gram unit of thyroid tissue there is less thyroxin than in the normal gland or in toxic adenoma, yet the blood in Graves' disease is saturated with an impure or imperfectly manufactured thyroxin. It would seem as if the threshold for thyroxin retention in Graves' disease is disturbed and that in so far as the thyroid itself is concerned, we are dealing with a perverted threshold mechanism for thyroxin and probably a dysfunction. The excess of thyroxin in toxic adenoma is more in the nature of pure hypersecretory activity with no threshold disturbance.

Clinical observation shows that, aside from that percentage of the community that have rheumatic hearts, the cardiac apparatus in Graves' disease is an effective instrument, and that the hyperthyroidism, per se, does not induce structural heart disease. Quite contrary to this assumption is the cardiac disability in toxic adenoma where the heart is from 15 to 20 years older per group, and where definite myocardial changes are paralleling the hyperthyroidism.

Our opinions on postoperative thyroid tetany are extremely nebulous. We

have not observed this phenomenon in a single instance after seven complete ablations of the thyroid for heart disease; and yet the proximity of the parathyroids and the ever present possibility of injury is greater in ablation than in resection. We have observed occasionally two interesting signs which we have interpreted as indicating postoperative perturbation of parathyroid function; namely, pain immediately below the manubrium and over one shoulder extending down the arm. One, and occasionally both, of these pain localizations, when present, have been without any of the classical signs of tetany. It is our feeling that they have been relieved and dissipated by the administration of calcium lactate, one teaspoonful every four hours, plus some combination of A and D vitamins.

We have had a small number of patients who have very definitely become myxedematous. Possibly about three cases in the last 500 thyroid operations for hyperthyroidism have very definitely developed rather well marked clinical myxedema, with basal metabolism readings from minus 15 to as low as minus 30. This is not a happy postoperative sequela and yet it seems to be inevitably linked with thyroid surgery.

Doctor McQuillan's statistics show a remarkable infrequence of pneumonia after thyroid operations. Tracheitis and postoperative aphonia arising on the third or fourth day are not in this category. Injury to the recurrent laryngeal nerves is always a possibility and when bilateral is a rather alarming sequela. It is well to remember, however, that late paralysis may occur from cicatrization and may not be due primarily to direct nerve injury. It is our custom to record the voice immediately upon the cessation of the ethylene anesthesia so that the subsequent development of hoarseness can be considered in the light of a tracheitis, which offers a good prognosis for recovery.

Doctor McQuillan has presented a very painstaking analysis of the morbidity following 1,400 operations on the thyroid gland. It is gratifying to record that his experience is in keeping with present day goiter thought and to note that his results have been so uniformly satisfactory.

THE SURGICAL TREATMENT OF PULMONARY ABSCESS

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THE opinion is widespread among thoracic surgeons that the advantages of early surgical drainage in appropriate cases of pulmonary abscess are not fully recognized by the majority of internists. The failure of the internist to appreciate these advantages is partly due to the fact that he does not see the end-results of surgical treatment. His contact with a case is interrupted in most instances when it is transferred to the surgical service. Later, if death or an unfavorable result follows the operation, surgery sometimes comes in for criticism which it does not deserve. Also it seems to be true that prejudice against the surgical treatment of pulmonary abscess still exists because of the high mortality associated with operation in former years. In order that the internist may become more familiar with the present day results of surgical treatment in these difficult cases, the following review has been prepared.

Indications for Surgical Drainage.—It has been variously stated that from 20 to 50 per cent of all pulmonary abscesses recover without surgical intervention. These are the cases that drain freely by way of a bronchus and the indications that they are improving are in general well appreciated. The most reliable are: Resolution of the surrounding zone of pneumonic consolidation; decrease in the size of the cavity; a subsidence of fever; improvement in cough; decrease in sputum; and improvement in the general condition of the patient. The first two indications are best determined by roentgenologic examination.

When an abscess does not drain at all, or does not drain adequately through a bronchus, the manifestations of infection persist and the patient will not recover unless drainage is provided by operation. The length of time that expectant treatment should be continued cannot be stated definitely. In discussing the optimum time for operation Eggers[1] has said, "I think all thoracic surgeons are agreed that the earliest time consistent with safety is the best time, as it is most likely to lead to complete restitution to normal. Operations done very early during the acutely septic stage of the disease have a very high mortality and should be avoided. Then also one should give nature a chance." It is difficult to be much more definite than this. The statement clearly summarizes my attitude toward the problem and has governed the decision to operate in the few cases in this series that were seen early in the course of the disease. The majority of lung abscesses that heal

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spontaneously show a tendency to do so during the first six to eight weeks after onset. When a case does not, external drainage should be established. Most of the cases reported here were far beyond this period when they came under my observation. The hope that they could be cured by medical means no longer existed. Surgery was the only curative procedure that remained.

Results of Treatment in 34 Consecutive Cases (Tables I and II).—The information obtained from follow up observations on a series of surgically treated pulmonary abscesses suggests the following classification of results:

Group I. Cases healed and symptom free.

Group II. Cases resulting in a bronchial fistula, but otherwise symptom free.

Group III. Cases resulting in open residual cavities.

Group IV. Cases healed, but with symptoms of persistent disease.

Group V. Postoperative deaths.

Group VI. Late deaths from disease after operation.

Groups I and II include the most favorable results and in general Group III is more favorable than Group IV.

In the series reported, 109 operations have been carried out to date during the treatment of 37 abscesses in 34 persons. In evaluating the results, it is considered significant that 29 of the 34 primary abscesses (or 85 per cent) had existed for more than six weeks before the first operation was performed; 28 (or 82 per cent) had existed for more than two months; 22 (or 65 per cent) for more than three months; 13 (or 38 per cent) for more than six months; seven (or 21 per cent) for more than one year; three for more than two years; two for more than five years; and one for 15 years.

The abscess which requires surgical drainage may occupy any one of the five lobes. In this series of 34 cases, 15 were in the upper lobes and were equally distributed between the two sides; four were in the right middle lobe; 11 in the right lower; and four in the left lower. The large percentage of upper lobe abscesses in this series is of interest in view of the common belief that drainage through a bronchus is more likely to effect a cure when the abscess is in the upper lobe.

Group I. Cases Healed and Symptom Free.—Of the 34 cases in this series 16 (or 47 per cent) now have healed wounds and are symptom free. Only nine (or 26 per cent) of these, however, healed after drainage alone. In the other seven cases simple drainage over a reasonable period of time, although usually followed by a drop in temperature, diminution in cough, decrease in expectoration, and improvement in general condition, was not sufficient to produce healing. Healing was prevented by the rigidity of the surrounding tissue and the formation of a lining of mucous membrane in the cavity which apparently had originated in the bronchi that opened into it. In most instances these bronchi were connected with deeper spaces in the adjacent fibrotic and atelectatic lung and continued to discharge pus. In some instances in which drainage was adequate there was a gradual narrowing of the fistulous tracts and a progressive decrease in the amount of discharge.

Three of the seven cases that did not heal after simple drainage were subsequently treated by lobectomy and the other four were treated by excising the mucous membrane lining the residual cavity and approximating the walls of the cavity with interrupted sutures to close the fistulae. In order to provide efficient drainage, one of the lobectomy cases and two of the cases in which the fistulae were closed were subjected to an intervening cautery pneumonectomy. One of the latter developed a secondary abscess of the right upper lobe which required three operations before healing of the primary abscess of the left lower lobe was obtained.

Group II. Cases Resulting in a Bronchial Fistula but Otherwise Symptom Free.—Three cases of the series developed fistulae. As all were free of symptoms it is presumed that none had residual cavities in the lung. One died of a streptococcal wound infection and septicemia following an appendicectomy 22 months after the surgical attack was completed. The other two are still under observation and doing well. Two of the cases in this group had cautery pneumonectomies. The third received a lobectomy immediately after a preliminary period of drainage because drainage was inadequate and the cavity was too near the hilus for cauterization. An undrained collection of pus was discovered in the interlobar space between the upper and lower lobes.

TABLE I

RESULTS OF SURGICAL TREATMENT IN THIRTY-FOUR CONSECUTIVE CASES OF PULMONARY ABSCESS

Result	After rib resection without drainage	After simple drainage in one or more stages	After simple drainage plus one or more other procedures	Totals	Percentage
Group I Healed and symptom free		9	7	16	47
Group II Symptom free but with fistula			3	3	9
Group III With open residual cavities			5	5	15
Group IV Healed, but with symptoms of persistent disease			2	2	6
Group V Postoperative deaths	1	5	1	7	20
Group VI Late deaths from disease after operation		1		1	3
Totals				34	100

Group III. Cases Resulting in Open Residual Cavities.—Five cases fall into this group and all had cautery pneumonectomies. Three are still under

TABLE II

SUMMARY OF CLINICAL DATA IN 34 CONSECUTIVE CASES OF PULMONARY ABSCESS

Case	Age	Origin of Abscess	Location	Duration of Abscess*	Operations	Complications	Period of Hospitalization†	Result	Length of Follow-Up
1 (J.C.)	58	Postpneumonic	R.L.L.	19 days	A, C	None	1½ mos.	Healed wound. Symptom free	2⅓ yrs.
2 (E.B.)	40	Postpneumonic	L.L.L.	5 wks.	A, C, C	None	3¾ mos.	Healed wound. Symptom free	1 yr.
3 (M.Z.)	40	Postpneumonic	R.M.L.	2 mos.	B, G, H	Pneumonia; infected costal cartilage; osteomyelitis of rib	1⅔ mos.	Healed wound. Symptom free	3¾ yrs.
4 (O.V.)	36	Began as an acute respiratory infection	L.U.L.	2½ mos.	B	None	23 days	Healed wound. Symptom free	6 mos.
5 (J.M.)	52	Followed tonsillectomy	L.U.L.	4 mos.	A, C, I	Osteomyelitis of sternum	1½ mos.	Healed wound. Symptom free	3¼ yrs.
6 (H.K.)	34	Followed tonsillectomy	R.U.L.	9¼ mos.	B, J	Pneumonia	3 mos.	Healed wound. Symptom free	5½ yrs.
7 (B.M.)	10	Followed tonsillectomy	R.U.L.	10 mos.	A, C	None	35 days	Healed wound. Symptom free	3 mos.
8 (M.K.)	28	Followed tonsillectomy	R.L.L.	10 mos.	B	None	19 days	Healed wound. Symptom free	4 mos.
9 (L.T.)	49	Began as an acute respiratory infection	R.U.L.	2⅓ yrs.	A, C	None	1 mo.	Healed wound. Symptom free	3½ yrs.
10 (G.H.)	8	Began as an acute respiratory infection	L.L.L.	20 days	K, B, B, B, B, F	None	1 yr.	Healed wound. Symptom free	7½mos.
11 (C.Q.)	21	Followed tonsillectomy	R.M.L.	4⅔ mos.	A, C, F	None	2½ mos.	Healed wound. Symptom free	1 yr.
12 (M.B.)	27	Followed tonsillectomy	R.L.L.	10½ mos.	B, L, D, F	None	3 mos.	Healed wound. Symptom free	5½ mos.
13 (J.M.)	32	Postpneumonic	R.U.L.	4 mos.	A, C, E	None	1½ mos.	Healed wound. Symptom free	3⅓ mos.

14 (R.D.)	23	Followed appendicectomy	L.L.L.	4½ mos.	B, D, D, D, L, D, D, E, and A, C, K on right	Abscess of right upper lobe; two severe hemorrhages after last cauterization of left lower lobe; pneumothorax on right side	8 mos.	Healed wound. Symptom free	2 yrs.
15 (I.G.)	32	Followed incision and drainage of abscess of throat	R.L.L.	5⅔ yrs.	A, D, D, E	None	3 mos.	Healed wound. Symptom free	3⅓ yrs.
16 (F.K.)	15	Began as an acute respiratory infection	R.L.L.	15 yrs.	?, B, E	None	3⅓ mos.	Healed wound. Symptom free	10 mos.
17 (J.G.)	23	Followed submersion in salt water (drowning accident)	L.U.L. multiple	2 mos.	A, C, D, D, I	Empyema	5½ mos.	Several small fistulae; otherwise symptom free. Died of a streptococcal wound infection and septicemia following appendicectomy 22 mos. after surgical attack was completed	22 mos.
18 (G.B.)	9	Followed tonsillectomy	R.L.L.	6 mos.	A, C, D	Cerebral embolism (air?) with hemiplegia and impaired vision from which he has almost completely recovered	4 mos.	Very small external fistula, but otherwise symptom free	11½ mos.
19 (A.O.)	35	Followed tonsillectomy	R.L.L.	5¼ mos.	B, F	Cellulitis of the chest wall; this abscess was associated with an interlobar empyema	2 mos.	One large fistula and a small cavity in the pleura which is rapidly closing down	2 mos.
20 (M.M.)	32	Followed gastrectomy and peritoneal abscess	R.U.L. multiple	36 days	A, D, D, J, B, D, D, E	None	8 mos.	Residual cavity with fistulae; still under treatment	5 mos.
21 (S.H.)	40	Postpneumonic	R.M.L.	3 mos.	A, C, D, D	None None	2½ mos.	Residual cavity with fistulae; still under treatment	1½ yrs.
22 (H.S.)	20	Began as an acute respiratory infection	L.U.L.	6 mos.	A, C, D, I D	Phlebitis	3⅓ mos.	Residual cavity with fistulae; persistent sinus; still under treatment	6½ mos.

TABLE II—*Continued*

Case	Age	Origin of Abscess	Location	Duration of Abscess*	Operations	Complications	Period of Hospitalization†	Result	Length of Follow-Up‡
23 (L.T.)	43	Followed inhalation of smoke from forest fire	L.U.L.	1⅙ yrs.	A, C, D	None	2 mos.	Residual cavity with fistulae; returned to England and is now under observation in that country	2⅔ yrs.
24 (L.G.)	59	Followed a herniotomy	R.U.L.	2⅔ mos.	A, C, D	Hemorrhage from vessel in chest wall—easily controlled	3¼ mos.	Residual cavity with fistulae; patient had diabetes and died of unknown cause after discharge from the hospital	1⅓ mos.
25 (H.C.)	36	Followed tonsillectomy	L.U.L.	4¼ mos.	A and later A and C for abscess of R.U.L.	None related to operation, but patient subsequently developed an abscess of the right upper lobe which may have been present from the beginning	4⅓ mos.	Healed wound, but still has cough	2 yrs.
26 (A.E.)	26	Followed suspension of the uterus	R.L.L.	5⅔ mos.	B	Two attacks of so-called "pneumonitis"	2½ mos.	Healed wound, but still has cough and occasionally blood-tinged sputum	4⅔ yrs.
27 (J.Z.)	27	Followed incision and drainage of abscess of larynx and tracheotomy	R.U.L.	1⅔ mos.	B	Pneumonia	2 days	Died of pneumonia on the second day after operation	2 days

28 (J.B.)	30	Followed a fight in which several teeth were lost, but no teeth were found in lung	L.U.L.	2 mos.	A, C	Localized pneumothorax; localized empyema; pneumonia	10 days	Died of pneumonia on the third day after the the second stage	10 days
29 (C.Z.)	29	Direct extension through diaphragm of abscess of kidney	L.L.L.	6 mos.	A	Pneumonia	3 days	Died of pneumonia on the third day after operation	3 days
30 (A.C.)	33	Followed tonsillectomy	R.U.L.	1½ yrs.	A, C	Pneumonia	10 days	Died of pneumonia on the first day after second stage	1 day
31 (G.L.)	34	Postpneumonic	R.L.L. R.M.L.	1⅛ yrs.	A, C, D, D, D, I,	Pneumonia following last operative procedure	4½ mos.	Died of penumonia on the fourth day after the last operative procedure	4 days
32 (E.H.)	46	Postpneumonic	R.L.L.	8 mos.	B	Heart failure	5 days	Died of heart failure on the fifth day after operation	5 days
33 (T.A.)	77	Followed prostatectomy	R.L.L.	21 days	B	See result	20 mins.	Died 20 mins. after operation of extensive gangrene of the lung (a hopeless case)	20 mins.
34 (J.S.)	34	Followed tonsillectomy	R.M.L.	1⅓ yrs.	A, C and later A, C for R.L.L. abscess	None related to operations, but patient developed secondary abscesses in central parts of right lower and right upper lobes	2⅔ mos.	Died of a massive hemorrhage from the lung 2½ yrs. after the middle lobe abscess was drained	2½ mos.

* Before first operation
† After surgery was started.
‡ Since last surgical procedure.

A = Rib resection (first stage).
B = Rib resection and drainage (one stage procedure).
C = Drainage (second or subsequent stage).
D = Cautery pneumonectomy.
E = Closure of fistula.
F = Lobectomy.
G = Exploration of wound.
H = Excision of costal cartilage.
I = Ostectomy.
J = Plastic on wound.
K = Intercostal drainage.
L = Pneumolysis.

treatment; one returned to his home in England and is now under observation there; the other, a diabetic, died of an unkown cause following discharge from the hospital.

Group IV. Cases Healed, but with Symptoms of Persistent Disease.—Two cases in the series healed after simple drainage, but were not completely relieved of symptoms. One of these had two abscesses. The original abscess in the left upper lobe healed after a first stage rib resection (undrained). The persistence of symptoms in this patient was throught to be related to a secondary abscess in the right upper lobe. The persisting cough and expectoration in these two cases suggest that they have residual cavities in the lung.

Group V. Postoperative Deaths.—Seven patients died in the immediate postoperative period: five of pneumonia, one of heart failure, and one of extensive gangrene of the lung which was present at the time of operation. One of the deaths following pneumonia occurred in a patient who had survived six previous operations.

Group VI. Late Deaths from Disease after Operation.—The remaining patient in the series, a chronic case of 16 months' duration before operation, died of a massive hemorrhage from the lung two and one-half years after drainage of an abscess of the right middle lobe and 88 days after drainage of a secondary abscess in the right lower lobe. Necropsy revealed undrained abscesses in the central parts of all three lobes.

Discussion.—The results show that 68 per cent of the cases that survived operation failed to heal satisfactorily after simple drainage. Most of these had to be subjected to other more complicated and hazardous procedures. These necessitated long periods of hospitalization which frequently involved the patients in serious economic problems. The added risk, the expense and the difficulties which accompany the more radical operations are the important reasons for operating earlier upon the cases which do not show progressive healing during the acute phase of the disease. In most instances simple drainage, provided it is efficient, will suffice in the early cases.

It is of the utmost importance, then, that internists seek the coöperation of a thoracic surgeon when the patient first comes under observation. Each will profit by the knowledge and experience of the other and the result will be a better understanding of the problem and a wiser choice of cases for operation. Furthermore, when a surgeon operates upon a case which he has observed from the onset of the disease, it is natural for him to feel a greater personal responsibility in the result obtained than when he is forced to operated upon a neglected case which he fears will cause him or his method to be held unjustly responsible for a poor result.

Operative Technic.—Successful drainage of a pulmonary abscess depends on accurate localization of the cavity. This is best accomplished by roentgenologic examination. A lateral film of the chest in addition to stereoscopic postero-anterior views is particularly helpful. Fortunately, most lung abscesses (over 9 per cent) show a cavity with a fluid level at some time during their development which can be easily seen.

The use of a slight Trendelenburg position at operation is of advantage so that exudate will drain into the mouth rather than be aspirated into uninvolved parts of the lungs.

In most instances it is advisable to perform the operation in stages. This is essential when the lung is not adherent to the chest wall in order to produce adhesions and avoid a pyopneumathorax. If the lung is firmly adherent and the abscess has been accurately localized, it is safe to drain immediately. It is well to remember, however, that a lung thought to be firmly adherent to the chest wall may be only loosely attached and may break away. At the first stage generous segments of two or more ribs are resected, including periosteum, intercostal muscles and thoracic fascia in order to expose a large surface of the parietal pleura. The wound is then dressed with a silk and iodoform gauze tampon to stimulate the formation of adhesions. If the abscess has not been accurately localized several small safety pins may be attached to the pleura for use as markers in subsequent roentgenograms. Six to eight days later the cavity is located by aspiration and opened with the needle *in situ*. The electric cautery is recommended for unroofing the cavity because with it the intervening lung tissue can be coagulated before it is excised and bleeding can be reduced to a minimum. The tissue is cut away piecemeal until the cavity is reached. This is sometimes done in stages, but does not involve the excision of lung tissue beyond that which is required to unroof the cavity. When the cavity is reached it is important to apply suction through a small opening and evacuate it immediately to prevent the aspiration of exudate into uninvolved parts of the lungs.

After drainage is established dressings should be done at frequent intervals. If drainage is not adequate pus will continue to escape from the fistulae in the cavity. The position of the deep pockets should then be determined by roentgenologic examination after the installation of lipiodol either through the wound or through the trachea. After this, in one or more stages the operator cautiously cauterizes along the sinuses which serve as guides. The intervening tissue is first coagulated and then excised piecemeal until all of the pockets have been opened. When the cavities are restricted to the peripheral part of the lobe where the blood vessels are small, this can be accomplished without any serious risk of hemorrhage. In the central part of the lobe, however, where the blood vessels are large, there is a real danger of hemorrhage and the use of the cautery is contraindicated. The risk of air embolism is also probably greater in this part of the lung.

When efficient drainage has been established the wound should be given ample time to heal. If drainage is instituted early and maintained adequately over a sufficiently long period of time, the wound will probably heal completely. If, on the other hand, operation is delayed too long, the end-result is almost certain to be a residual cavity and fistulae. Three choices then remain to the surgeon: To do nothing more, either he, or his patient, or both being satisfied with the result obtained; to close the wound; or to excise completely the remaining part of the lobe by lobectomy. When efficient drainage is not obtainable with the cautery, lobectomy is the only curative procedure.

The choice between closure of the wound and lobectomy depends on whether or not there is a sufficient amount of uninvolved lung tissue remaining to make the closure possible. If the cavity extends into the region of the hilus, closure of the wound is usually unsuccessful and lobectomy is to be preferred.

The procedure which I have used for closing a wound with a residual cavity and fistulae was developed by Lebsche.[2] The mucous membrane lining

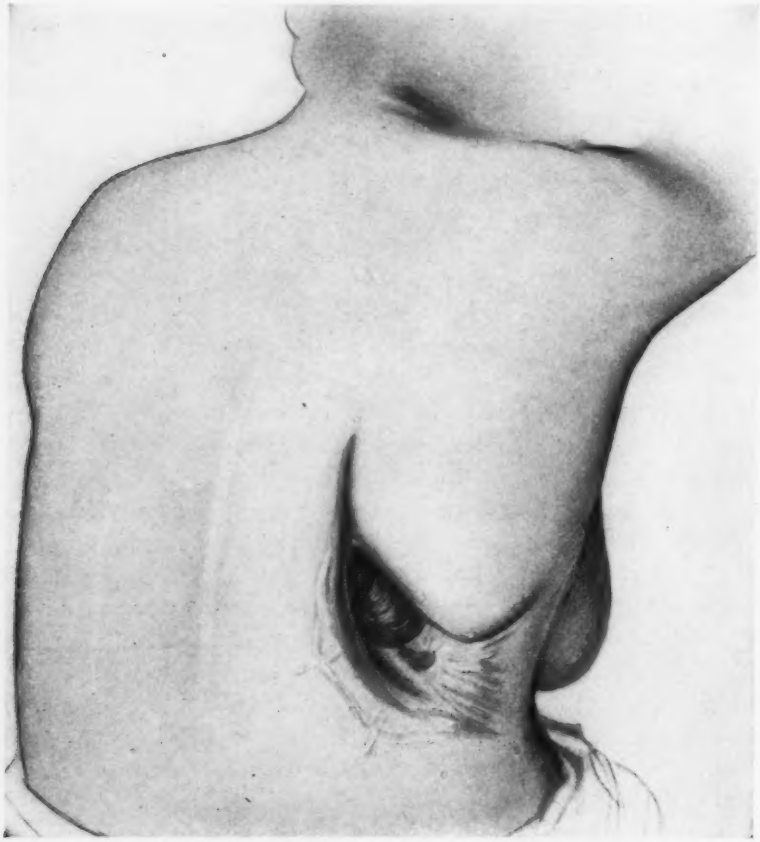

FIG. 1.—A typical end-result showing a residual cavity with multiple fistulae after cautery pneumonectomy for chronic abscess and bronchiectasis of the right lower lobe. In this case the abscess had existed for five and one-half years before the surgical attack was begun. Efficient drainage was established at a second stage cauterization January 4, 1930. The illustration was made June 20, 1932, approximately two and one-half years later. On the following day (June 21, 1932) the mucous membrane lining the cavity was excised and the lung was closed with several rows of interrupted silk sutures. The wound healed rapidly after this and the patient has remained free of symptoms ever since. This case was considered a suitable one for closure of the cavity because an adequate amount of uninvolved lobe remained to make closure possible.

the cavity is first excised and then the lung is closed with several rows of interrupted silk sutures. The wound is then dressed with a silk and gauze tampon and allowed to granulate. In carrying out this procedure it is advisable to resect additional segments from the ends of the rib stumps that surround the wound in order to permit the soft parts of the chest wall to be drawn in during healing. It may also be advisable to paralyze the diaphragm in order to prevent tugging on the suture line. There are occasional

cases of chronic cavity with fistulae which, even though the cavity is in the peripheral part of the lung, are not suitable for this procedure. These are the cavities at the extreme apex of the lung, some of which lie behind, or even extend above the first rib. In some instances it may be possible to close such a cavity with a pedicle muscle flap.[3] The other alternative is lobectomy, which is usually undesirable in these cases because of the danger of injuring the great vessels and the difficulty of exposing the lobe and obliterating the resulting dead space.

Lobectomy.—Lobectomy for residual cavity and fistulae is indicated when extensive fibrosis of the lobe makes closure impossible. The sinus in the chest wall is excised down to the surface of the lung. Then the lobe is freed by sharp and blunt dissection. After amputation the stump is closed. If free pleura has not been entered the wound is dressed with a tampon and allowed to granulate. If, on the other hand, free pleura has been entered with resulting collapse of the other lobe, the wound is closed with pressure maintenance drainage. In either case the bronchi in the stump may reopen, but unless some residual bronchiectasis remains in the stump the chances of ultimate healing are excellent. In two of the four lobectomy cases in the series it was possible to amputate the lobe without opening free pleura. In the other two, although free pleura was opened and some collapse occurred, the remaining dead space was satisfactorily obliterated.

Lobectomy for primary bronchiectasis has been successfully accomplished with increasing frequency during the past five years. On the contrary, there are surprisingly few reports in the literature of cases of chronic abscess with secondary fibrosis and bronchiectasis that have been treated by this procedure. My personal experience with lobectomy is based on 21 operations. Fifteen of these were for primary bronchiectasis; one was for a lesion which was thought to be a tumor, but which proved to be an encapsulated abscess from which Aspergillus fumigatus was recovered; another, a bilobar lobectomy, was for carcinoma; the other four were for chronic abscess and have been included in this report (Cases 10, 11, 12 and 19). One of the bronchiectasis patients, with involvement of the entire right lung, died on the operating table while an attempt was being made to free the middle lobe several months after the lower lobe had been successfully removed. The patient with carcinoma survived 20 months and died of the disease. The remaining 19 cases are living today and are either well, or greatly improved.

It is of interest to compare the technical difficulties encountered at operation and the postoperative course of the cases of lobectomy for chronic abscess after drainage and the cases that were operated upon for primary bronchiectasis. In three of the former cases adhesions between the two pleural surfaces were much more extensive than those usually encountered in cases of primary bronchiectasis. However, they were separated without great difficulty and instead of proving to be an impediment, as is commonly believed, were considered an asset because of their stabilizing effect on the mediastinum. The contrast between the response of the two types of cases to operation was even greater. In all of the bronchiectasis cases the post-

operative course was stormy, due in most instances to obstruction of bronchi by exudate which apparently had come from the diseased lobe during the manipulation necessary to free it. The symptoms of this complication were absent in the abscess cases because, as a result of the prolonged periods of drainage, the secretions from the diseased lobe had been either eliminated completely or reduced to an insignificant amount. For this reason when it is possible I prefer to establish efficient drainage before considering lobectomy. However, all cases of open residual cavities that follow drainage and cautery pneumonectomy for chronic abscess cannot be cured by lobectomy. The effort to free an upper lobe had to be abandoned in one of the cases in this series because of the density of the adhesions. Furthermore, it is not justifiable to draw conclusions from an experience based on only four cases. The fact remains, however, that lobectomy was feasible in the four cases reported and that all four have apparently been cured by it. This would seem to be sufficient reason for its trial in a greater number of similar cases, especially since the technic of lobectomy has been improved so much in the past few years that the operation is now being performed on selected cases and under favorable conditions with a mortality that is less than 10 per cent.

Anesthesia.—Some form of local anesthesia is preferred as it eliminates pain without destroying the cough reflex. For resection of the ribs at the first stage, paravertebral nerve block with local infiltration (novocain) is very satisfactory and has been used in most of these cases. For cauterization at the second and subsequent stages occasionally no anesthetic at all is required. Usually, however, the patient is apprehensive from the noise and smell of the smoke and a general anesthetic such as nitrous oxide has to be administered. In most instances, however, nitrous oxide alone will not control the patient and should be combined with another anesthetic such as avertin. Avertin, however, should be avoided if possible in those cases that have a large amount of sputum, because of the danger of aspiration during the long period of unconsciousness after operation.

Complications.—The serious complications of surgical drainage include pneumonia, hemorrhage, empyema, cellulitis of the chest wall, and air embolism. Pneumonia is the most frequent of these. It is usually lobular and is presumably due to the aspiration of exudate that is spilled into the bronchial tree during operation. It was responsible for five of the six deaths in the immediate postoperative period which occurred in my series. Severe hemorrhage is not infrequent. It may occur when a vessel in the chest wall is insecurely ligated, or when the cautery is used injudiciously in the central part of the lung where the pulmonary vessels are large. It may also occur when coagulated tissue separates after eight to ten days. In the peripheral parts of the lung where the vessels are smaller, hemorrhage is less likely to occur and is more easily controlled by packing. Empyema is a complication which should not occur if care is taken not to open the abscess before the lung is securely adherent to the chest wall. If the lung is loosely adherent there is always danger that it may separate either at operation or later during a severe coughing attack or dressing. Air embolism is rare. In order to

avoid it, it is important when using the electric cautery to coagulate thoroughly before cutting and then not to cut deep to the coagulated area.

The less serious complications include osteomyelitis of a rib or of the sternum, infection of a costal cartilage, and persistent sinuses due to residual cavities of the pleura at the site of operation. These cavities are caused by the regeneration of bone which bridges over the pleura forming a dead space and prevents the soft parts of the chest wall from being drawn in during healing. They are the result of inadequate resection of rib and periosteum at the first stage. It is particularly important when draining abscesses that are situated posteromedially in the paravertebral gutter that the rib segments be excised as far back as the transverse processes of the vertebrae to prevent the formation of a shelf. Infection of costal cartilage should be avoided by resecting the entire cartilage at the first stage when an upper lobe or middle lobe abscess requires drainage anteriorly. Care should be taken not to cut into the sternum because of the danger of osteomyelitis. These less serious complications rarely cause death, but are troublesome because they require additional operations for their correction and delay the patient's recovery.

SUMMARY.—An analysis of 34 personal cases of surgically treated pulmonary abscesses showed that 28 (or 82 per cent) had existed for more than two months and 22 (or 65 per cent) for more than three months before the first operation was performed. The initial surgical treatment in all of these patients was rib resection and drainage in one or more stages. Six patients died in the immediate postoperative period. Of the 28 that survived the simple drainage operations, spontaneous healing and relief of symptoms occurred in only nine. The remaining 19 patients had to be subjected to other more complicated and hazardous procedures such as cautery pneumonectomy and lobectomy. Simple drainage was not sufficient to effect a cure in these patients because of extensive fibrosis and bronchiectasis due to the prolonged period of medical care.

CONCLUSIONS

(1) The internist should always coöperate with a thoracic surgeon when a case of pulmonary abscess first comes under observation so that each may profit by the knowledge and experience of the other.

(2) External drainage should be instituted in all cases that do not show sustained improvement six to eight weeks after the onset of the disease.

(3) Lobectomy should be attempted in selected cases of chronic abscess with wounds that do not heal after simple drainage and cautery pneumonectomy.

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THE EFFECT OF HISTIDINE ON THE EXPERIMENTAL PRODUCTION OF PEPTIC ULCER *

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PEPTIC ulcer can be produced consistently in dogs by employing Mann and Williamson's[1] procedure of surgical duodenal drainage. The latter consists of replacing the duodenum in its relation to the stomach with the jejunum and deviating the bile, pancreatic juice and duodenal secretion into the lower portion of the ileum (Fig. 1).

Weiss and Aron[2] found that the ulceration in the jejunum following such a procedure could be prevented by the subcutaneous administration of histidine. As a result of this observation, the theory was advanced that peptic ulcer is the local manifestation of a metabolic disease produced by the deficiency of an amino acid, such as histidine. The present investigation was undertaken with the idea of extending this work in certain directions and this report is based upon some preliminary observations of the effectiveness of histidine in the prevention of peptic ulcer experimentally.

Procedure.—Six experiments were performed. Healthy normal dogs were used. The operations were carried out under inhalation ether anesthesia and with an aseptic technic. The jejunum was divided about 10 cm. below the ligament of Treitz. The pylorus also was sectioned. The duodenal stump was closed and inverted with fine silk sutures. The distal end of the severed jejunum was anastomosed, end-to-end, to the pyloric portion of the stomach, while the proximal end was anastomosed, end-to-side, to the ileum at a distance varying from 30 to 60 cm. from the ileocecal junction (Fig. 1). The anastomoses were made with two layers of No. 00 plain catgut sutures. No clamps were applied to the intestines.

During the first three days following operation, the animals received daily an intravenous injection of a varying amount of 5 per cent glucose in physiologic salt solution. They were fed soft boiled rice for the next three days. From then on they were maintained on a diet consisting of rice, meat and vegetables.

The administration of histidine was started on the third day after operation in each case and continued daily until the experiment was terminated. Five cubic centimeters of a sterile, isotonic, 4 per cent solution, representing 0.2 gr. of l-histidine-monohydrochloride, were given subcutaneously each day.

* A generous supply of l-histidine-monohydrochloride in the form of Larostidine "Roche" was provided for this investigation through the kindness of Mr. M. Zeller of F. Hoffmann-La Roche & Co., Ltd., Basle, Switzerland. Submitted for publication January 25, 1937.

Results.—The essential data in this investigation are summarized in Table I. The period of observation varied from 15 to 36 days. Progressive loss of body weight and emaciation occurred in each case. The total weight loss averaged 3.2 kilograms, but in one instance it amounted to as much as 5.5 kilograms in 31 days. Tarry stools were observed during the last few days of the experiment in some cases.

Two dogs died 31 and 36 days respectively after the institution of surgical duodenal drainage, and a third dog was sacrificed on the fifteenth post-operative day on account of extreme weakness and cachexia. In two of these dogs, no ulcer in the gastro-intestinal tract could be found. In the case of the third dog, which lived 31 days, necropsy revealed a perforating chronic ulcer, 2x1.5x0.5 cm., on the posterior wall of the jejunum just beyond the line of anastomosis between the stomach and the jejunum. A second ulcer, also chronic and perforating in nature and measuring 1 cm. across, was located on the superior wall of the jejunum immediately distal to the first one (Fig. 2, No. 498).

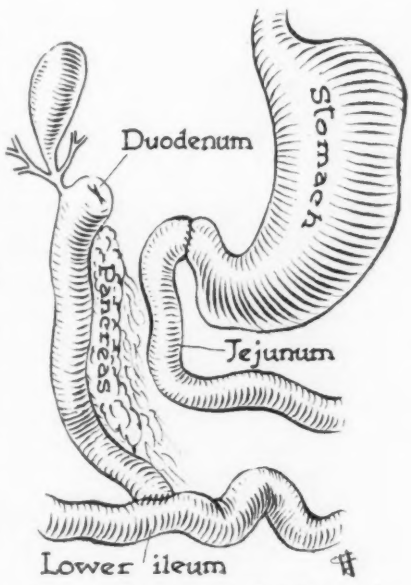

FIG. 1.—Diagram illustrating the procedure devised by Mann and Williamson[1] for the experimental production of peptic ulcer.

Three dogs were kept under observation for 28, 28, and 29 days, respectively. An exploratory celiotomy was performed when the animal was very weak and emaciated. One or two peptic ulcers were found in each instance. One of them had a subacute ulcer, 1x1x0.5 cm., on the posterior wall of the jejunum just beyond the line of anastomosis between the stomach and the jejunum (Fig. 2, No. 504). Another one had a chronic ulcer, 2x1x0.8 cm., on the posterior wall of the jejunum just distal to the pylorus (Fig. 2, No. 506). The third one had a perforating subacute ulcer, 0.8x0.6x0.4 cm., on the anterior superior wall of the jejunum and a second subacute ulcer, 0.8x 0.8x0.4 cm., on the posterior inferior wall of the jejunum immediately beyond the pylorus (Fig. 2, No. 507).

Comment.—In this series of six experiments, four dogs developed single or multiple ulcerative lesions in the jejunum in spite of the administration of histidine. Ulcers were not found in the remaining two dogs, but one of them was sacrificed at a time which may have been too early for inflammation and ulceration to have developed.

These results are definitely at variance with those reported by Weiss and Aron. In one of their series of four dogs which received daily a subcuta-

neous injection of 0.05 Gm. of histidine and 0.025 Gm. of tryptophan, the integrity of the mucous membrane of the stomach and the jejunum was found to have been maintained three, three, six and ten weeks after the operation to produce peptic ulcer. In another series of two dogs which received daily 1 cc. of a 4 per cent solution of histidine subcutaneously, one of them showed no erosion or inflammation of the gastric or jejunal mucosa after eight weeks. The second dog died from the perforation of a small ulcer at the end of eight weeks after the administration of histidine had been inadvertently omitted during the last four days of survival. In three other dogs which received daily injections of unspecified amounts of histidine and tryptophan, not even superficial ulceration was found at the usual site of ulcer formation five, six and ten weeks after surgical duodenal drainage.

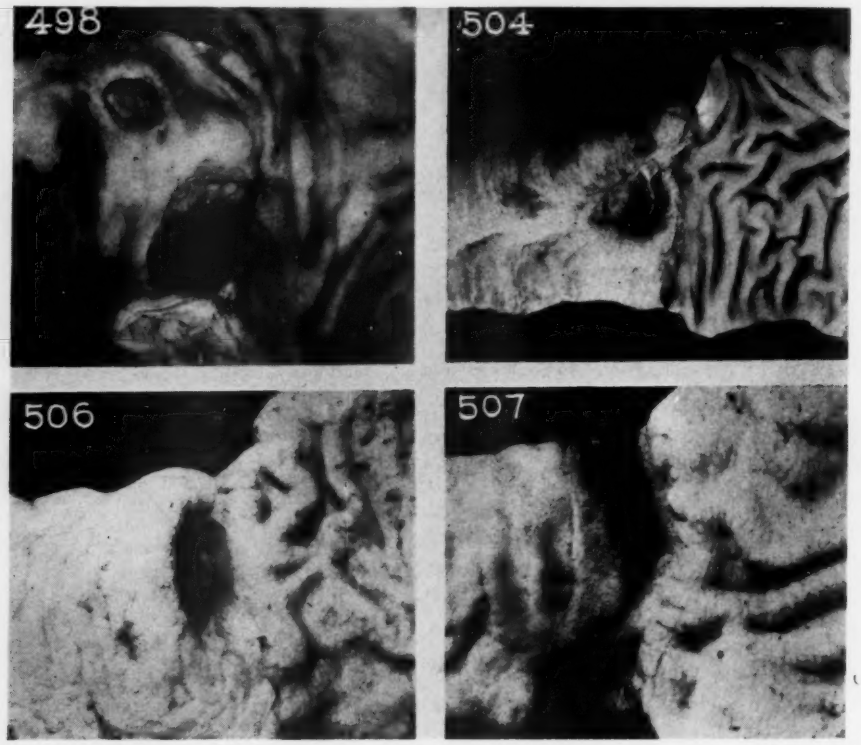

FIG. 2.—Photographs of specimens showing the peptic ulcers which developed in spite of the administration of histidine in dogs Nos. 498, 504, 506 and 507.

In view of the discrepancy in the results, certain differences in the experimental procedures used should be pointed out. In this study, the administration of histidine was begun on the third day after surgical duodenal drainage when the survival of the animal following operation was assured. Five cubic centimeters of a 4 per cent solution, representing 0.2 Gm. of histidine, were used. This is four times the dosage used in some of their experiments and five times that used in the others.

On the basis of this investigation, it is not possible to offer a satisfactory explanation for our failure to confirm the observations made by Weiss and Aron. Further studies of the effect of histidine on the experimental production of peptic ulcer are indicated.

TABLE I

SUMMARY OF RESULTS

Dog No.	Date of Drainage Operation (and Weight)	Date of Exploratory Celiotomy (and Weight)	Date of Death (and Weight)	Findings at Exploratory Celiotomy or Necropsy
486	7/30/35 (9.8 kilos)		9/4/35 (7 kilos)	No ulcer found
497	8/20/35 (8.5 kilos)		9/4/35 (6 kilos)	No ulcer found
498	8/20/35 (11.5 kilos)		9/20/35 (6 kilos)	Perforating chronic ulcer, 2x1.5x0.5 cm., on posterior wall of jejunum just distal to pylorus. Another perforating ulcer, 1 cm. across, on superior wall just beyond the first one
504	8/27/35 (10 kilos)	9/24/35 (6.3 kilos)		Subacute ulcer, 1x1x0.5 cm., on posterior wall of jejunum just distal to pylorus
506	9/4/35 (8.5 kilos)	10/3/35 (6.2 kilos)		Chronic ulcer, 2x1x0.8 cm., on posterior wall of jejunum just beyond line of gastro-jejunal anastomosis
507	9/5/35 (10 kilos)	10/3/35 (8 kilos)		Perforating subacute ulcer, 0.8x0.6x0.4 cm., on anterosuperior wall of jejunum just beyond pylorus. Second subacute ulcer, 0.8x0.8x0.4 cm., on postero-inferior wall of jejunum just beyond pylorus

SUMMARY.—The purpose of this study was to determine the effect of histidine on the experimental production of peptic ulcer. Mann and Williamson's procedure to produce peptic ulcer was used. Two-tenths of a gram of histidine was administered subcutaneously daily from the third day following surgical duodenal drainage until the experiment was terminated. Four out of six dogs developed one or two peptic ulcers within 28, 28, 29 and 31 days after operation, respectively, while the other two dogs did not show such lesion after 15 and 36 days, respectively. These results do not agree with those which have been reported by Weiss and Aron. Further investigation of this problem is indicated.

REFERENCES

[1] Mann, F. C., and Williamson, C. S.: The Experimental Production of Peptic Ulcer. ANNALS OF SURGERY, 77, 409, 1923.

[2] Weiss, A. G., and Aron, E.: Rôle des amines dans l'évolution de l'ulcère expérimental: Influence de l'histidine. La Presse Méd., 41, 1880, 1933.

GASTRIC OPERATIONS FOR BENIGN AND MALIGNANT CONDITIONS

A STATISTICAL STUDY

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FOR an accurate estimation of the value of any surgical measure directed toward the cure of gastroduodenal conditions, the necessity of a periodic systematic follow up is obvious. Internists, forced to care for the seemingly hopeless gastric derelict, are often too pessimistic and surgeons too optimistic as to what may, or may not, be expected from certain procedures.

Almost all reports on mortality and end-results, now accessible, have come either from university clinics or from the clinics of individual surgeons particularly interested in this subject. No previous survey, so far as is known to the author, has emanated from a relatively small private hospital in an American city of average size. These conditions militate to a certain extent against accuracy, first because of the small number of cases and second, because, instead of one person's estimate based on clinical, chemical and roentgenologic check up, the determination of end-results is dependent upon the opinions of the various attending physicians, whose interest in these cases is, of course, variable.

The material here studied consists of 137 cases operated upon at the Jewish Hospital of Cincinnati during the 11 year period from 1924 to 1934 (Table I). The operations were performed by 19 surgeons. Sixty-six per cent of the survivors were followed. Ninety-seven per cent were followed by personal questioning of their physicians, 3 per cent by questionnaire. The shortest period of follow up was two years, the longest, 11.

Use is made of percentage in this paper but with the realization that it is of but pragmatic, comparative value.

GASTRIC CARCINOMATA.—*Age and Sex Incidence.*—The 50 cases of carcinomata were composed of 29 males (58 per cent) and 21 females (42 per cent). Fifty-nine per cent of the nonresectable group and 55 per cent of the radically resectable were males. The nonresectable group was, on the average, 1.3 years older than the resectable—57 to 58.3 years, with extremes in ages respectively 38-72 and 31-75 years. No case in this series occurred before the age of 30, the youngest being 31.

Operations.—The 18 resectable cases were operated upon 15 times according to the Billroth II method, twice according to the Billroth I and once by segmental resection. The 32 nonresectable cases were treated by the following measures: Exploratory laparotomy 15, gastro-enterostomy 16, and

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palliative resection one. The percentage of resectability was 36 (Table III); this compares with such quotients as Gatewood's,[1] 27 per cent; Lewisohn's,[2] 35 per cent; Finsterer's,[3] 65 per cent, and Mayo's,[4] 35 per cent (Table IV). Since no treatment other than radical resection is of avail in gastric cancer, its use should be extended to the utmost. Only one palliative resection was performed. This operation could unquestionably have been more extensively used; practically all of those cases in which gastro-enterostomy was used might have been palliatively resected. Actually, all resections are in a sense palliative, as it is impossible to ascertain accurately the carcinomatous extension. In no case was the omentum included in the resection. In the one case in which a sleeve resection was performed, there was rapid recurrence with obstruction requiring a gastro-enterostomy.

TABLE I

DISTRIBUTION OF PRIMARY CASES BY ENTITY

	Number of Cases			
A. Malignant	54			
(1) Carcinoma		50		
(a) Resectable			18	
(b) Nonresectable			32	
(2) Sarcoma		4		
B. Benign	83			
(1) Ulcers		71		
(a) Nonperforated			53	
(1) Gastric ulcer				26
(2) Duodenal ulcer				26
(3) Gastric and duodenal ulcer				1
(b) Perforated			18	
(1) Gastric ulcer				6
(2) Duodenal ulcer				12
(2) Negative findings and questionable cases		6		
(3) Congenital pyloric stenosis		6		
Total	137			

TABLE II

AGE AND SEX INCIDENCE OF THE CASES OF CARCINOMA

		Age		Sex	
	No.	Average	Extreme	Male	Female
Resectable carcinoma	18	57.0	38–72	10	8
Nonresectable carcinoma	32	58.3	31–75	19	13
Total	50	57.8	31–75	29	21

Operative Mortality.—The gross operative mortality for the 50 gastric carcinomata was 46 per cent, for the 18 resected cases, 44 per cent, for the 16 gastro-enterostomies, 50 per cent, and for the 15 simple exploratory laparotomies, 47.3 per cent (Table V). While the mortality in this series had dropped in the resectable group from 58 per cent, between 1924–1929,

to 15 per cent, between 1930–1934, the nonresectable group mortality had risen from 30 per cent, between 1924–1929 to 75 per cent, between 1930–1934.

These data can be compared to the following: St. John,[5] 36.6 per cent; Sprung,[6] from Anschuetz Clinic at Kiel, 30 per cent for complicated and 27 per cent for simple resections. Sprung[6] noted a drop of 20 per cent in the mortality connected with improved technic over a 30 year period.

TABLE III

OPERATIVE METHODS IN THE CASES OF CARCINOMA

Resectable		Nonresectable	
Billroth I	2	Exploratory laparotomy	15
Billroth II	15	Gastro-enterostomy	16
Segmental resection	1	Palliative resection	1
Total	18	Total	32

TABLE IV

COMPARATIVE QUOTIENT OF RESECTABILTIY IN CANCER

Jewish Hospital (Cincinnati)	36%
Presbyterian Hospital (Chicago)	35%
Finsterer (Vienna)	65%
Mayo (Rochester)	35%

TABLE V

OPERATIVE MORTALITY IN THE CASES OF CARCINOMA

Resectable carcinoma	44.0%
Nonresectable carcinoma	46.9%
Gastro-enterostomy	50.0%
Exploratory laparotomy	47.3%
Total	46.0%

Kocher[7] was able in three successive series to reduce his mortality from 34.6 to 17 per cent and finally to only 9 per cent. Mayo[4] reported a mortality of 13.7 per cent for resections, 2.9 per cent for exploration, and 11.1 per cent for such palliative operations as gastro-enterostomy. Finsterer[3] reported 19.4 per cent; 6.1 per cent in simple and 41 per cent in complicated resections. Gatewood,[1] in the Presbyterian Hospital series, found the percentage of mortality for resection to be 18, Lewisohn,[2] at Mt. Sinai, 33 per cent. St. John,[8] in resections for the period 1923–1932, reports 26 per cent mortality, and Seifert, from 1921 to 1931, 23 per cent (Chart 1).

Morbidity and Causes of Death.—Sixty-six per cent of the nonresectable and 83 per cent of the resectable cases developed some complication attributable to the operation; where pneumonia was a sequel of peritonitis, the former was not considered.

Fatal complications in the resectable group were divided into peritonitis, 63 per cent, secondary hemorrhage, 12.5 per cent, and pulmonary embolism, 12.5 per cent. In the nonresectable group, death from peritonitis was 6

per cent; pulmonary complications accounted for 33 per cent, secondary hemorrhage for 13 per cent, cachexia for a like percentage and vicious circle for 6 per cent (Table VI). Three cases which died within two months of discharge from the hospital are arbitrarily included in the hospital deaths.

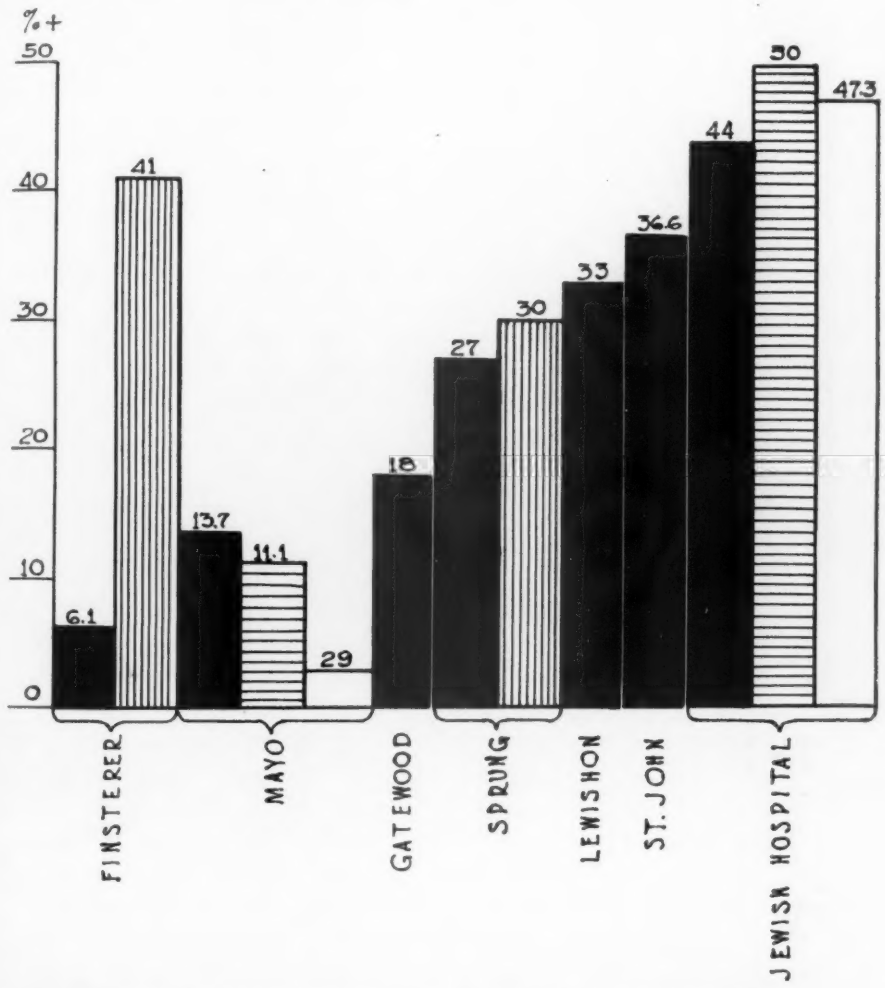

CHART 1.—Comparative mortality statistics in operations for gastric cancer.

The nonfatal complications in the resectable cases were bronchitis, 37.5 per cent, anastomotic obstruction, 37.5 per cent, and infection of the incision, 25 per cent. In the nonresectable cases pulmonary complications amounted to 83 per cent, and stomal obstructions, 17 per cent. In both groups it was impossible in some cases to determine the complication.

TABLE VI

FATAL POSTOPERATIVE COMPLICATIONS IN THE CANCER CASES

	Resectable	Nonresectable
Peritonitis	63.0%	6%
Secondary hemorrhage	12.5%	13%
Pulmonary embolus	12.5%	—
Pulmonary complication (other than embolus)	—	33%
Cachexia	—	13%
Circulus	—	6%

For the entire cancer series the morbidity from pulmonary causes amounted to 28 per cent as compared with 19.4 per cent at Denk's Clinic. In the entire series among the fatal cases peritonitis was the etiologic factor in more than one-fourth (26 per cent).

The high incidence of pulmonary complications as a cause of death in the group in which either only an exploratory laparotomy or a gastroenterostomy had been performed contrasts conspicuously with the incidence of fatal peritonitis in those cases treated definitively. Possibly the use of weak hydrochloric acid lavage as a preoperative measure would have minimized if not abolished the danger of peritoneal infection.

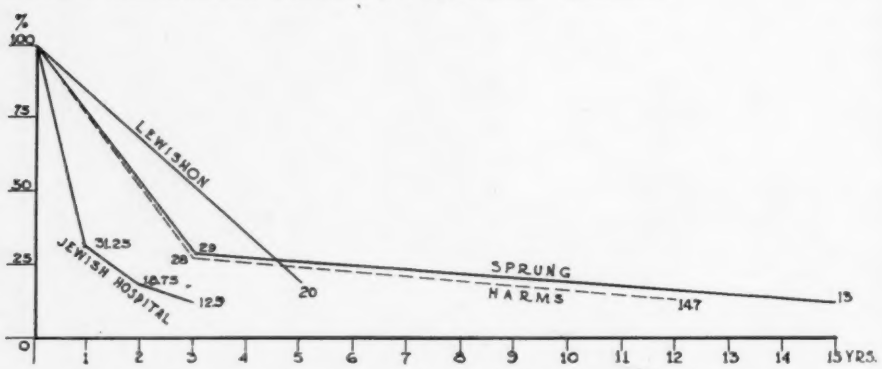

CHART 2.—Illustrating the recurrence—free survival percentages following resection.

Late Results.—The recurrence-free survival, figured in percentage of resections, is graphically depicted in Chart 2. Of the 18 cases considered resectable, only two are now alive. One of the 18, since his sleeve resection, has had a secondary operation for obstruction and since then radiation for a recurrence in the scar. Slightly more than one-tenth were alive and recurrence-free at the end of three years. These cases had had no lymphatic involvement at the time of the operation. This compares with Sprung's[6] figures of recurrence-free survival of 29 per cent, at three years, and 13 per cent, at 15 years; Harms'[11] 28 per cent, after three years, and 14.7 per cent, after 12 years; and Lewisohn's[2] 20 per cent, survival after five years (Chart 2).

Balfour's[12] 50.0 per cent, after five years, and Gatewood's[1] 46.1 per cent, after five years and longer, are percentages based on postoperative re-

coveries instead of resections. St. John[5] found 21 per cent well after five years in 38 cases followed. On this basis the figures for this series are 25 per cent for three year survivals without recurrence. Two patients died of intercurrent disease, pneumonia and cerebral hemorrhage. Both lived for three years without recurrence. The remaining patients died of recurrence.

Of the 17 nonresectable cancers surviving operation, only three lived for one year; of these, one was an exploratory laparotomy and two gastro-enterostomies.

Although the number of cases is obviously too small to split, the Billroth II method did have to its credit the only two and three year survivals. This is contrary to the experience of some clinics where the Billroth I is employed for the easier cases and the Billroth II reserved for the more complicated.

The group operated upon were all of the uncomplicated type, that is, there was no adherence to neighboring organs requiring simultaneous resection. Six of those surviving the operation had had no lymphatic involvement at the time of operation. In all the lesion had been freely movable.

Gastric Sarcomata.—There were four gastric sarcomata, an unusually high incidence. All but one occurred in males. The average age was 50.6 years and the extremes 42 to 61 years. In one a Billroth II resection was performed while the others had simple excision of the mass together with the involved wall. There was no hospital death in this group. One patient developed a postoperative pneumonia and one a skin infection. The results in the three cases followed for one, four and eight years, respectively, were excellent. One patient, with a large extragastric sarcoma in whom an excision had been effected, developed a recurrence in one year and died 1.5 years postoperatively.

Congenital Pyloric Stenoses.—There were six cases of congenital pyloric stenosis; all but one in male infants. The average age was six weeks, the extremes 2.5 to 12 weeks. An unmodified Rammstedt operation was performed in all without a death. In two there was complete dehiscence of the wound requiring repair; otherwise, there was no serious complication. The results in the five cases followed were excellent.

Gastroduodenal Ulcers.—Gastric and duodenal ulcers will be considered as one entity, in the belief that, except for the danger of malignant degeneration in the former and the greater proneness of the latter to develop jejunal ulcers when treated with gastro-enterostomy, they are essentially the same. The term jejunal ulcer is used in its inclusive sense as synonymous with such terms as marginal, stomal and gastrojejunal.

There were 71 ulcers, of which 18 perforated freely into the peritoneum and 53 were nonperforated.

Because of the failure to employ radical measures, practically no pathologic data are available, and the obvious error of classifying only one of these cases as having gastric and duodenal ulcers simultaneously is made.

The late results are divided into four groups, the first two probably belonging together:

(1) Excellent: Those remaining asymptomatic.

(2) Good: Those remaining asymptomatic except when they eat certain foods.

(3) Fair: Those, without demonstrable jejunal ulcer, having more or less severe indigestion unless they adhere strictly to an ulcer dietetic regimen.

(4) Failure: Those who suffered from a vicious circle, adhesions, or postoperative-gastric or jejunal ulcer as well as those who, even if otherwise symptom free, have had one or more episodes of hematemesis.

Perforated Gastric and Duodenal Ulcers.—*Incidence.*—About one out of every four ulcers proved to be freely perforated. The seasonal incidence for duodenal and gastric ulcers varied, one-half of the duodenal ulcers occurring between March and May and one-half of the gastric ulcers between June and August, with the remaining cases being fairly evenly distributed throughout the year. The fewest cases were found during the winter months.

A familial incidence in two brothers was noted. There were no multiple simultaneous perforations. There were two instances of reperforation of the same ulcer: one perforation recurred at one year and one at 26 months. Pich[14] claims a secondary perforation, following suture, has been reported but twice, once by Heyman, in 1930, and once by Tessenyi, in 1927. Haberer,[15] however, had seen repeated perforations following suture in a number of cases.

In three cases there were premonitory symptoms of threatened penetration ending in a free perforation, and in one instance marked faintness was noted immediately before the perforation.

Age and Sex Incidence.—Of the 18 cases, only one was a female; this is an excessive male preponderance which, however, closely corresponds to the ratio at the Heidelberg Clinic,[16] 6.1 per cent. The greatest number of duodenal cases, 54.5 per cent, fell between the thirtieth and fiftieth year, and 50 per cent of the gastric ulcers occurred in the sixth decade. The average for the entire group was 40 years, extremes 18 to 63; for duodenal ulcers, 35.3, extremes 18 to 63; and gastric ulcers, 49.5, extremes 31 to 59. The patients with ruptured duodenal ulcers were roughly ten years younger than those with perforated gastric ulcers (Table VII).

Table VII

AGE AND SEX INCIDENCE OF PERFORATED ULCER

	No. of Cases	Age		Sex	
		Average	Extreme	Male	Female
Duodenal ulcer	12	35.3	18–63	11	1
Gastric ulcer	6	49.5	31–59	6	—
Total	18	40.0	18–63	17	1

Operative Procedures.—Suture of the perforation was effected 14 times, with the suture occasionally reënforced with omental tabs. In three cases the perforation was not sutured, once because a McBurney incision had been made, due to a preoperative diagnosis of appendicitis, and twice because it was thought that the condition of the patient did not warrant a search for the perforation. These three had simple "general" peritoneal drainage and oddly enough only one died, though the other two developed serious complications (abscess in lesser peritoneal cavity and obstruction from the contracting nonsutured ulcer). In ten cases which were sutured, drainage was considered necessary. In two of these the drain was placed, apparently, down to the suture line; one of these cases developed a duodenal fistula and died following its attempted closure; the other was one of the two cases which had a second perforation of the same ulcer. In only three of the 18 cases was drainage dispensed with. In only one of the primary cases was a gastro-enterostomy added to the suture.

In the repeated perforations the second operation in one was excision of the ulcer and gastro-enterostomy, and in the other, because of the large size of the perforation and the inability to close it, a Billroth II "pylorectomy" was performed. No elective resection was undertaken, nor was Neumann's method used.

TABLE VIII

COMPARATIVE GROSS MORTALITY STATISTICS FOR PERFORATED ULCER

Author	Mortality Per Cent
Willich *	28.6
Radoievitch *	30.2
Bager	32.8
Jewish Hospital	33.3
Bruett *	34.6
Zukschwerdt and Eck	37.0
Noetzel	38.0
Wohlleben *	47.8
Neumann *	62.0

* Quoted by Zukschwerdt and Eck.

Mortality.—The mortality for the combined group was 33.3 per cent corresponding closely to other series, *e.g.*, Bager,[17] 32.8 per cent, Noetzel,[18] 38 per cent, Zukschwerdt and Eck,[16] 37 per cent (Table VIII). Of the gastric ulcers, 66.6 per cent, and of the duodenal ulcers, 16.6 per cent, died.

The interval between perforation and operation is, of course, of great prognostic importance. In this group those who recovered were operated upon in the average time of 10.3 hours (extremes 2.25 to 25.5 hours) after perforation, while the fatal cases were operated upon in the average time of 19.2 hours (extremes 5.5 to 36.5 hours). The average time interval for the entire gastric group was six hours longer than for the duodenal group.

The only death among those cases operated upon within the first six hours was in a young man whose postoperative course was uncomplicated

for the first 11 days but in whom, on that day, a dehiscence of the wound occurred, possibly from an infection due to a broken needle inadvertently left in.

There is a tendency toward increase in mortality with increasing age (Table IX).

TABLE IX

CORRELATION BETWEEN AGE AND MORTALITY IN PERFORATED ULCERS

Age	No. of Cases	Mortality Per Cent
10–20	3	33
20–30	1	—
30–40	3	33
40–50	5	40
50–60	3	33
60–70	2	50

Perforated duodenal ulcers carry a lower mortality than do perforated gastric ulcers (Table X).

TABLE X

CORRELATION BETWEEN LOCATION OF ULCER AND MORTALITY IN PERFORATED ULCERS

Site of Ulcer	No. of Cases	Mortality Per Cent
Upper third of stomach	2	50.0
Middle third of stomach	—	—
Pyloric third of stomach	3	100.0
Duodenal	18	33.3

A definite correlation exists between the length of the ulcer history and the size of the perforation. In nine cases in which these two factors could be accurately estimated, seven with a long history had perforative ostia averaging 13.3 Mm. in diameter, while two with perforations without prior ulcer history had ostia of 0.5 to 1.0 Mm. in diameter (Fig. 1). Both of these latter cases recovered. Manifestly, other things being equal, the amount of peritoneal soiling will parallel the size of the opening and the mortality will parallel the soiling. Hence, perforations in chronic ulcers are more dangerous than those which occur without antecedent history of ulceration.

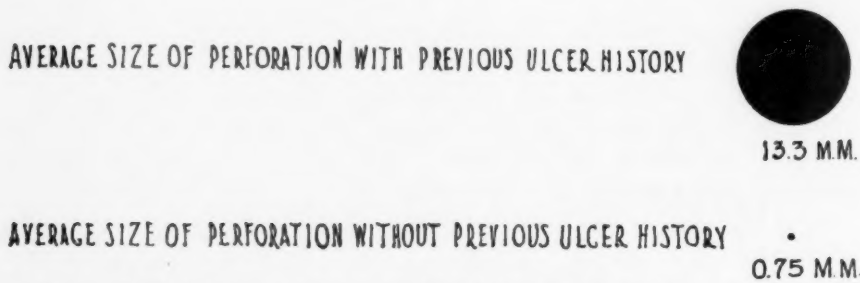
AVERAGE SIZE OF PERFORATION WITH PREVIOUS ULCER HISTORY
13.3 M.M.
AVERAGE SIZE OF PERFORATION WITHOUT PREVIOUS ULCER HISTORY
0.75 M.M.

FIG. 1.—Correlation between size of perforation and duration of ulcer history.

Morbidity and Cause of Death.—Peritonitis accounted for four (66 per cent) of the fatal cases, corresponding identically with Brunner's[19] statistics: a duodenal fistula repair for one, and wound dehiscence for the sixth. The last should possibly be considered as due directly to peritonitis. Three deaths may be attributed to technical or diagnostic errors; two of these being due to failure to close the perforation, and one to the impingement of the drain on the suture line (Table XI).

TABLE XI

FATAL COMPLICATIONS IN PERFORATED ULCER CASES

Complication	Gastric Ulcer	Duodenal Ulcer	Total
Persistent peritonitis....	4	—	4
Duodenal fistula.....	—	1	1
Wound dehiscence.....	—	1	1

The incision was infected in seven cases, and twice broke down throughout, requiring repair during the immediate postoperative period; one ventral hernia was repaired later. Symptoms of peritonitis persisted after operation in eight. Two developed obstructive symptoms, one serious enough to necessitate a subsequent gastro-enterostomy after a lapse of six months. One, as noted above, developed a duodenal fistula. Four had pulmonary involvement and one nephritis. One case, in which the perforation had not been sutured, later had an abscess about the hepatic flexure, which was drained.

LATE RESULTS.—Five (55 per cent) of the nine cases followed were completely symptom free and one was but slightly inconvenienced by occasional mild indigestion. One perforated gastric ulcer continues to have rather severe symptoms from a concomitant duodenal ulcer, known to have been present at the time of perforation. It is surprising that this does not occur more often, in view of the frequency of multiple ulcers.

Of the two cases with repeated perforations, the one in whom the resection was performed is completely well, while the other, in whom an excision with gastro-enterostomy was performed, has a jejunal ulcer both clinically and roentgenologically (Table XII).

TABLE XII

LATE RESULTS FOLLOWING PERFORATION

Operative Method	No. of Cases	Hospital Mortality	Follow Up	Results (1)	(2)	(3)	(4)
Suture.....	16	6	8	4	1	—	3*
No suture.....	2	—	1	1	—	—	—

* Two of these reperforated; one had a secondary pylorectomy and is now asymptomatic, the other was resutured, had a gastro-enterostomy added, and now has a jejunal ulcer.

NONPERFORATED GASTRIC AND DUODENAL ULCERS.—*Age and Sex Incidence.*—Of the 53 nonperforating gastric and duodenal ulcers, 40 were males and 13 females. The sex distribution was practically the same in both gastric and duodenal groups. The average age was 45.4 years with

extremes of 23 to 70; these figures approximate both the gastric and duodenal ulcer groups, considered separately, within a fraction of a year (Table XIII).

TABLE XIII

AGE AND SEX INCIDENCE IN THE NONPERFORATED ULCERS

	No. of Cases	Age		Sex	
		Average	Extreme	Male	Female
Duodenal ulcer	26	45.7	25–68	20	6
Gastric ulcer	27 *	45.0	23–70	20	7

* Including one case of combined gastric and duodenal ulcer.

Operative Procedures.—Fifty indirect operations were performed consisting of 48 gastro-enterostomies, one ulcer excision and one cauterization of the ulcer. In three of the 48 gastro-enterostomies, excision of the ulcer was added. In the duodenal group, only gastro-enterostomy was used. The three direct operations on ulcer were all undertaken under the mistaken operative diagnosis of cancer; they consisted of one sleeve resection, one Billroth II and one Schmieden resection of the lesser curvature. Two cases, because of technical difficulties, were reoperated upon, gastro-enterostomy being effected at the second operation. In two cases cholecystectomy, and in five appendicectomy was also included. The gastro-enterostomy was almost always retrocolic posterior, only once antecolic (Table XIV).

TABLE XIV

OPERATIVE PROCEDURE AND MORTALITY FOR NONPERFORATED ULCERS

	Duodenal Ulcer			Gastric Ulcer			Gastroduodenal Ulcer		
Operative Method	No.	P.O.+	+%	No.	P.O.+	+%	No.	P.O.+	+%
Billroth II				1	1		1		
Schmieden				1	1		1		
Sleeve				1	1		1		
Radical				3	3	100.0%	3	3	100.0%
Gastro-enterostomy	26	1	3.8%	22 *	3	13.6%	48	4	8.3%
Excision (knife or cautery)				2	0	0.0%	2	0	0.0%
Conservative	26	1	3.8%	24	3	12.5%	50	4	8.0%
Total	26	1	3.8%	27	6	22.2%	53	7	13.2%

* Including one case of combined gastric and duodenal ulcer.
+ = Died.

Mortality.—The hospital mortality for the combined group was 13.2 per cent, for the gastric ulcers, 22.2 per cent, and for the duodenal, 3.8 per cent. For gastro-enterostomy the mortality was 8.3 per cent, duodenal ulcers, 3.8 per cent, and gastric ulcers, 13.6 per cent. All three of those subjected to resection died. As gastro-enterostomy was employed routinely rather than as an "operation of necessity" the mortality of 8.3 per cent should be compared with the following figures: Haberer,[21] 3–5 per cent, Clairmont,[22] 5.1 per cent, Pannett,[23] 8.5 per cent, Gibbon,[24] 10.5 per cent, Finney and Hanrahan,[25] 10.6 per cent. The mortality for gastro-enterostomy in duodenal

ulcers compares most favorably with that of other clinics. However, the fourfold greater mortality for gastro-enterostomy in gastric ulcers as compared with duodenal ulcers contrasts strongly with the experience at the Hochenegg Clinic,[26] from 1923 to 1932, where death for gastro-enterostomy in gastric ulcers was 0.6 per cent and in duodenal ulcers 3.1 per cent (Table XV).

TABLE XV

COMPARATIVE MORTALITY FOR ELECTIVE GASTRO-ENTEROSTOMY IN VARIOUS CLINICS

Author	Mortality Per Cent
Haberer	3–5.0
Clairmont	5.1
Pannett	8.5
Gibbon	10.5
Finney and Hanrahan	10.6
Jewish Hospital	13.2

Although the mortality for resection in this group was 100 per cent, in those clinics in which it is the method of choice in the treatment of gastric and duodenal ulcers, the operative death rate varies from 2.3 per cent[23] to 5 or 6 per cent,[27] definitely lower, at least in these two instances, to the rate for gastro-enterostomy in the present series.

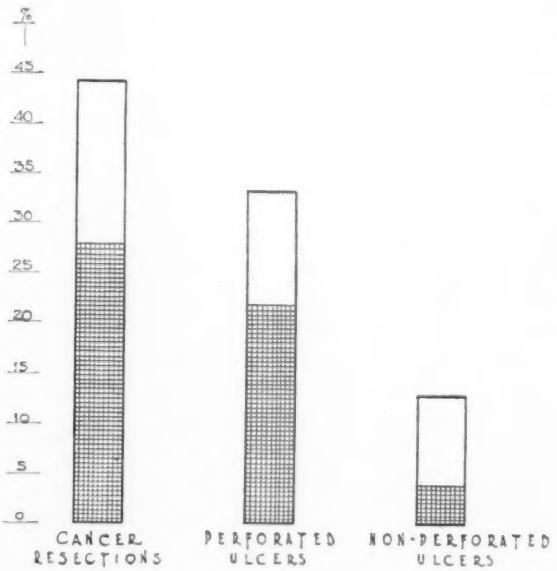

CHART 3.—Illustrating the total mortality (total bar) and the proportion of mortality due to peritonitis (cross-hatched) in resections for cancer and in operations for perforated and nonperforated gastroduodenal ulcer.

Morbidity and Cause of Death.—While peritonitis accounted, in the resectable cancer group, for 62.5 per cent of the deaths, only 28 per cent of the nonperforated ulcers died from that cause (Chart 3); this percentage

agrees closely with the experience of the Second Viennese Surgical Clinic[26] of 71 and 30 per cent, respectively. Both of the fatal cases of peritonitis followed resection, so that no nonperforated ulcer treated with gastro-enterostomy died of peritonitis. One patient died from hemorrhage from his ulcer following a gastro-enterostomy. One succumbed to an obstruction at the stoma with a subsequent gangrene of the lung; one to secondary hemorrhage and operative pancreatic injury (resection); one to a duodenal fistula with resultant subphrenic abscess and one to secondary hemorrhage (Table XVI).

TABLE XVI

FATAL COMPLICATIONS IN NONPERFORATED ULCER CASES

Operative Method	No. of Cases	Duodenal Fistula with Subphrenic Abscess	Peritonitis	Pancreatic Injury	Persistent Hemorrhage from Ulcer	Circulus	Secondary Hemorrhage
Billroth II	1						1*
Schmiden	1		1*				
Sleeve	1		1				
Radical	3		2	*			1
Gastro-enterostomy	48	1			1	1†	1
Excision (knife or cautery)	2						
Conservative	50	1			1	1	1

* Two pancreatic injuries associated with other causes of death.

† Lung abscess and circulus.

The nonfatal complications were 17 instances of wound infection resulting in one dehiscence and one ventral hernia; five transient stomal obstructions; eight pulmonary complications and one ileus probably due to a low grade peritonitis.

The morbidity from pulmonary complications was 15 per cent, identical with the experience of the Second Viennese Surgical Clinic.[10]

Late Results.—Of 28 nonperforated ulcers traced, 43 per cent were practically asymptomatic. These cases had all been operated upon by indirect methods; except for one knife and one cautery excision, gastro-enterostomy had been the method of treatment. 10.7 per cent were forced to remain on a strict dietary regimen. Outright failures amounted to 46.9 per cent. The results for the 27 nonperforated ulcers treated by gastro-enterostomy are practically the same as for the entire group treated indirectly; asymptomatic, 44.4 per cent; on strict diet, 11.1 per cent; and failure, 44.4 per cent. One of these failures was due to the development of a gastric cancer in the case which had had a cautery excision of the ulcer, an incidence of 8 per cent for cancer developing on an ulcer base in this series (Table XVII). Schwartz[28] found the incidence of cancer following gastro-enterostomy to be 6.5 per cent and Jean

Varnier,[29] 2–5 per cent. Haberer[30] believes gastric ulcer undergoes malignant degeneration in about 9 per cent of cases.

TABLE XVII

LATE RESULTS OF INDIRECT OPERATIONS FOR ULCER

		Indirect Operations			Late Results			
	No. of Cases	No.	Mortality	No. of Cases Followed	(1)	(2)	(3)	(4)
Duodenal ulcer—perforated	12	2	—	2	1	—	—	1
nonperforated	26	26	1	15	7	—	1	7
Total	38	28	1	17	8	—	1	8
Gastric ulcer—perforated	6	—	—	—	—	—	—	—
		(24)†		(13)				(6)
nonperforated *	27	22	3	12	5	—	2	5
		(24)		(13)				(6)
Total	33	22	3	12	5	—	2	5
Gastric and duodenal ulcer—perforated	18	2	—	2	1	—	—	1
		(50)		(28)				(13)
nonperforated	53	48	4	27	12	—	3	12
		(52)		(30)				(14)
Total	71	50	4	29	13	—	3	13
Questionable cases	6	4	1	2	—	—	—	2
		(56)		(32)				(16)
Total	77	54	5	31	13	—	3	15

* Including one case of combined gastric and duodenal ulcer.

† Figures in parentheses refer to gastro-enterostomy or excision, those not in parentheses, to gastro-enterostomy.

Comparable data from the literature relative to the percentage of cure in duodenal ulcers treated by gastro-enterostomy are: Hoffman,[31] 40.8 per cent; Finney and Hanrahan,[25] 62.7 per cent. In gastric ulcers: Balfour,[32] 50 per cent; Finney and Hanrahan,[25] 58.7 per cent; Starlinger,[33] 63.6 per cent; and for both gastric and duodenal ulcers: Enderlen and Zukschwerdt,[20] 28.5 per cent; and Brattstroem,[34] 66 per cent (Chart 4).

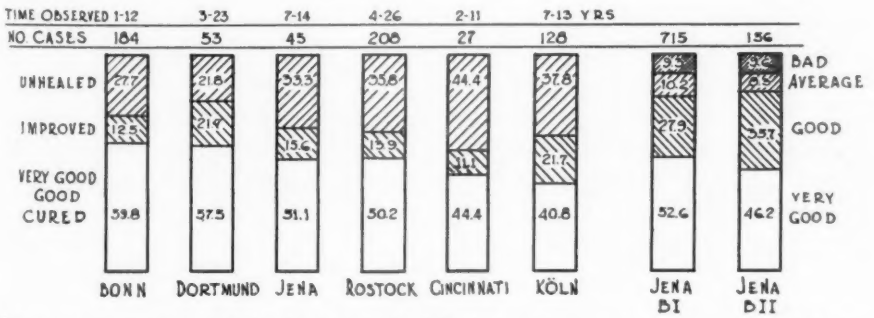

CHART 4.—Comparative statistics for late results following gastro-enterostomy for nonperforated ulcer (Harms[11]). Results following resection included for comparison.

Haberer,[21] representative of the resection school, says: "Gastro-enterostomy should be considered only as an operation of necessity, as its late results are poor."

The failures amounted to nearly 50 per cent, independent of whether the pathologic condition found at the time of operation was severe or mild.

The age of the patient at the time of operation is of marked importance. All patients in this series treated by gastro-enterostomy under 30 years of age were failures, all over 60 years successes (Table XVIII). This is in keeping with Enderlen's[20] statistics.

TABLE XVIII

CORRELATION OF AGE INCIDENCE AND THE RESULTS OF GASTRO-ENTEROSTOMY IN 29 PATIENTS

Years	Follow Up of Gastro-enterostomised Cases	Per Cent Cured
10–20	1	
20–30	3	0
30–40	8	50
40–50	9	44
50–60	6	50
60–70	2	100

Poor results were noted during the first year postoperatively and persisted for six years. A number of cases traced from seven to 11 years postoperatively had good results. Contrary to this experience many have marked the increasingly poor results with indirect methods with the lapse of time, *e.g.*, Clairmont,[22] Haberer,[15, 21, 27, 30] Starlinger.[33, 47]

Resection for ulcer yields cures in from 78[34] to 95 per cent,[35, 21] and resection for exclusion, in cases of nonresectable duodenal ulcers, about the same.[36, 20] No resection for exclusion was performed in this series.

QUESTIONABLE CASES.—Six patients were not included in the uncomplicated, nonperforated group of ulcers, as no ulcer was found at operation, but their symptoms of indigestion, hematemesis or melena or positive roentgenologic findings led to exploration, and in four cases, to the performance of a gastro-enterostomy. The failure to find an ulcer must be discounted because of the indirect procedures employed.

Age and Sex Incidence.—It is of interest that four of this group were women. The average age was 44.7 years (extremes 34 to 52 years).

Operative Procedures.—One had a simple gastrotomy; one a release of periduodenal adhesions and gastrotomy followed by a gastro-enterostomy, though no ulcer was found; two simple gastro-enterostomies; one an appendicectomy and release of adhesions, followed in three months by a gastro-enterostomy; the other an appendicectomy.

Mortality.—Only one patient died.

Morbidity and Cause of Death.—The one death in this group was due to peritonitis with terminal pneumonia. Three cases had infected incisions.

Late Results.—Two of the four cases followed remained well; both of these were in nongastro-enterectomized patients. The two cases followed, in whom gastro-enterostomy had been performed, were both failures.

JEJUNAL ULCER.—Of the 54 gastro-enterostomies performed for nonmalignant conditions, 31 were followed and, of these, four (12.9 per cent) were proved, at the corrective operation, to be suffering from jejunal ulcer. Five cases had both unquestionable clinical and roentgenologic evidence of jejunal ulcer. One of these was refused secondary operation because of a myocardial condition. These nine proved cases give an incidence of 29 per cent for jejunal ulcer following gastro-enterostomy. Three more cases, on the basis of repeated, almost fatal, hematemesis and other symptoms, are very strongly suspected of having stomal ulcers. Adding these to the foregoing, the incidence rises to 38.7 per cent. Finally, there are three patients, who, because of persistent indigestion with tenderness over the stoma are also suspected of harboring a stomal or jejunal ulcer; in one of these three, a roughened stoma, though without any niche, was demonstrated. Including all cases, both proved and suspected, the incidence of jejunal ulcer was 48.3 per cent (Table XIX).

TABLE XIX

THE RELATIVE OCCURRENCE OF JEJUNAL ULCER

	No. of Cases of Gast.-Ent. Followed Up	Jejunal Ulcer			
		Proved		Suspected	
		Oper.	Roentgen Ray	Strongly	Questionably
Duodenal ulcer					
Perforated	2	—	1	—	—
Obstructed	6	—	1	1	—
Uncomplicated	9	1†	1	2	1
Gastric ulcer					
Penetrated	4	2	1	—	—
Obstructed	1	—	—	—	—
Uncomplicated *	7	—	1	—	1
Questionable	2	1	—	—	1
Gastroduodenal ulcer					
Perforated	2	—	1	—	—
Nonperforated	27	3	4	3	3
Total	31	4	5	3	3

* Including one case of concomitant gastric and duodenal ulcer.

† Gastrojejunocolic fistula.

Contrary to the usual experience, which has found jejunal ulcer occurring about 20 times more frequently following gastro-enterostomy performed for duodenal ulcers than following gastro-enterostomy for gastric ulcers, eight in this series were in the duodenal group, five in the gastric and two in the questionable. Four in both the gastric and duodenal ulcers and one in the questionable group were proven by operation or roentgenologic examination. Of the two perforated ulcers with gastro-enterostomy, one developed a stomal ulcer. Of the six obstructed duodenal ulcers followed, 33.3 per cent developed

a jejunal ulcer, which was proven either by roentgenologic examination or strongly suspected.

Age and Sex Incidence.—Surprisingly, 50 per cent of the operatively proven cases were women. This is, of course, exceptional. In the total group of jejunal ulcers, there were four women and 11 men. The average age for the operatively proven group, at the time of the gastro-enterostomy, was 36 years with extremes of 23 to 52 years, and for the entire group 37, about eight years younger than for all nonperforated ulcers and 4.5 years younger than the entire ulcer group.

The average interval between gastro-enterostomy and the onset of symptoms indicating jejunal ulcer was, for the whole group, 2.1 years with extremes of six months to seven years. Seven of the 15 cases had either almost certain, or very suggestive symptoms of jejunal ulcer within six months of the gastro-enterostomy.

Operative Procedures.—All operations directed toward the cure of these marginal ulcers were conservative and consisted in one instance of taking down the gastro-enterostomy in the case in which a gastrojejunocolic fistula had occurred; one cauterization of the jejunal ulcer; one pylorectomy, under the mistaken impression that the finally fatal hemorrhage from the jejunal ulcer was due to the original pyloric lesion; and pylorectomy followed by enlargement of the stoma.

Mortality.—Only one of the group (25 per cent) died during the immediate postoperative period.

Morbidity and Cause of Death.—The one immediate postoperative fatal complication was persistent hemorrhage from a jejunal ulcer following pylorectomy. An ultimately fatal complication was rupture of the jejunal ulcer with fistula formation, subphrenic abscess and empyema. One case had bronchitis and infection of the incision, one slight ileus and cystitis, and one a smooth convalescence except for a perivascular infection and probable thrombosis following a continuous intravenous drip. Incidentally, this complication occurred three times in the entire series but was never the source of a fatal embolus.

Late Results.—Of the two patients, both women, still surviving the conservative corrective operations, one now has a recurrence of her old duodenal ulcer symptoms following the taking down of the gastro-enterostomy for a gastrojejunocolic fistula. The other had a steadily downward course following cauterization of the jejunal ulcer, so that, in 1935, she was described as greatly emaciated and as having general anasarca; since then there has again been improvement and no hematemesis for the last year, though she still requires almost daily gastric lavage. The conservative corrective operations, then, have been 100 per cent failures. A third case, surviving a series of conservative interferences, eventually died from perforation of his stomal ulcer.

COMMENT.—Jejunal and gastrojejunal ulcers have caused many surgeons, in the last two decades, to desert gastro-enterostomy for radical resection, in the surgical treatment of both gastric and duodenal ulcers. Such men as

Hurst,[41] Pannett,[23] Strauss,[42] Berg, Hinton,[43] Haberer, Enderlen, Kirschner and many others have become completely alienated from gastro-enterostomy largely because of this complication.

The 2 to 3 per cent incidence of jejunal ulcer quoted by many[32, 37, 38, 39, 40] cannot conceivably be correct in spite of "geomedical" considerations. Hurst and Stewart[41] showed the obvious fallacy in the estimation of these low figures to lie in the manner of their compilation.

Data relative to jejunal ulcer incidence following gastro-enterostomy, comparable to those presented in this series, are supplied by Strauss,[42] 25 per cent; Hinton,[43] 16.4 per cent; Lewisohn,[44] 34 per cent; Hurst and Stewart,[41] 52 per cent of all gastro-enterostomies from nine months to 19 years postoperative in the postmortem material at the University of Leeds, 73 per cent of all duodenal ulcers; and Enderlen and Zukschwerdt,[20] 11.1 per cent, in bleeding ulcer, 35.3 per cent, in stenosing ulcer, and 51.3 per cent, in perforating ulcer. Both Lahey[45] and Horsley[46] agree that this sequel occurs more frequently than is commonly admitted. Hinton[43] says that: "It is believed that the incidence of 16.4 per cent in cases of gastrojejunal ulcer is an underestimation." This same complication occurs following resection with a Billroth II type of anastomosis, but, according to Starlinger,[47] in a review of the material in the Central European clinics, in only 0.7 per cent of cases. It has often been remarked that the results of gastro-enterostomy grow worse with time, due to an increasing number of jejunal ulcers, while the reverse holds for resection.

In the cure of jejunal ulcer, resection should be the method of choice and a Billroth I anastomosis preferred. Taking down the gastro-enterostomy is possibly indicated where the gastro-enterostomy has been performed originally in the absence of an ulcer.

SUMMARY

A total of 137 consecutive gastric operations performed at the Jewish Hospital of Cincinnati, between 1924 and 1934, inclusive, are analyzed for mortality, morbidity, and end-result.

Fifty cases of cancer of the stomach had a 36 per cent quotient of resectability. The gross postoperative mortality was 46 per cent. The postoperative mortality for resection was 44 per cent for the 11 year period, but only 15 per cent in the last five years. A morbidity of 65 per cent for the nonresectable and 83 per cent for the resectable cases was found. Peritonitis caused 62 per cent of the deaths in those cases resected. Pulmonary complications occurred in 28 per cent of the entire cancer group. 12.5 per cent of the cases resected were recurrence-free at the end of three yars. Palliative resection was used but once and in no instance was the omentum included in the resection.

It is felt that to improve the results in gastric carcinoma, the limits of operability for both radical and palliative resections should be extended to the utmost.

Eighteen perforated gastric and duodenal ulcers had a gross mortality of

33 per cent with peritonitis accounting for two-thirds of these deaths. Seven perforated ulcers with a long preperforation ulcer history had ostia averaging slightly more than 13 Mm. in diameter while two in whom the perforation occurred without prior history had ostia of 0.5 to 1 Mm. This observation must be of prognostic value. About one-half of the cases followed were symptom free.

Fifty-three nonperforated gastric and duodenal ulcers had a mortality of 13 per cent. There was complete failure to cure in 46.9 per cent.

Of 31 gastro-enterostomies performed for benign lesions, 48.3 per cent (12.9 per cent operatively proved, 16 per cent clinically and roentgenologically proved, 9.7 per cent clinically positive and 9.7 per cent clinically suspected) developed jejunal ulcer. All patients under 30 years of age treated by gastro-enterostomy were failures. Because of the extreme frequency of jejunal ulcer, gastro-enterostomy should be discarded as a method of treatment for gastro-duodenal ulcer, except for a small, strictly selected group. Resection, and resection for exclusion, should be the methods of choice.

The results noted in this series indicate that the treatment of jejunal ulcer by conservative operative measures is not justified.

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INTUSSUSCEPTION DUE TO INTESTINAL TUMORS

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INTUSSUSCEPTION may be classified into a primary and a secondary group from its causative pathology, or into an acute, chronic or recurrent group from its clinical picture. The primary group usually has an acute onset, occurs at the ileocecal region chiefly in infancy, and once reduced rarely recurs. Gross causative pathology is seldom found. Many theories have been advanced to explain the cause of primary intussusception, *e.g.*, excessive lymphoid tissue in the terminal ileum, perhaps dietetic (Perrin and Lindsay[1]); mobile cecum (Leriche and Cavaillon[2]); incoördination of the autonomic system at the ileocecal region where the dual sympathetic and parasympathetic supply of the ileum gives way to the single sympathetic control of the large bowel (Fraser[3]). Morro[4] reported two cases of acute primary intussusception in adults which followed a Mohammedan fasting period; one was precipitated by a glass of water, the other by anticipation of food. Goodall[5] collected 122 cases of primary intussusception in adults; 60 per cent were between 20 and 40 years of age. The secondary group usually has a chronic or recurrent onset, occurs in adults and older children, and tends to recur if the causative pathology is not removed. Intestinal tumors, benign or malignant; intestinal ulcers due to typhoid, dysentery, and tuberculosis; and Meckel's diverticula are the most common underlying pathologic lesions. A rare case of intussusception due to gumma of the intestine was reported by Lyles.[6]

Frequently the presence of a small intestinal tumor is discovered by the occurrence of an intussusception which is more commonly due to a benign than a malignant neoplasm. In a series of 35 cases of benign tumors of the small intestine, of which the tumor was an incidental finding during laparotomy in 17 cases, Rankin and Newell[7] found that intussusception occurred in 17 per cent of the total, and in 33 per cent of the cases in which there were symptoms. This is to be contrasted with a series of 55 cases of carcinoma of the small intestine reported by Rankin and Mayo[8] in which intussusception was encountered in only two cases (3.6 per cent). Joyce[9] states that intussusception is a complication of about 30 per cent of the small intestinal tumors, although it occurred only twice in his nine cases (22.2 per cent). Raiford,[10] in his study of 50 benign and 38 malignant tumors of the small bowel, found an incidence of intussusception in 23 per cent, the majority being caused by benign growths. This figure is low because cases found at autopsy were included in his statistics.

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While intussusception in adults and older children is rare, its practical clinical significance with relationship to tumors or other gross causative pathology cannot be too strongly emphasized. Multiple and often irrelevant operations are frequently performed before the exact pathology is understood and corrected. Oughterson and Cheever[11] report the case of a woman of 22 who had an appendicectomy and a nephropexy performed without relief, then a reduction of an intussusception of the ileum without recognition of an underlying tumor, and finally a resection of the bowel for a recurrent intussusception due to a small lipoma. Cure followed. They reviewed 12 similar cases reported in the literature. Joyce[9] and Haggard and Floyd[12] have since reported cases requiring multiple operations. In Case 1 three operations were performed before the true pathology was recognized and corrected.

Of the benign tumors occurring in the small intestine, adenoma is the most common (Raiford, 17 per cent, Rankin and Newell, 31.4 per cent). It is generally stated that they rarely occur in the jejunum. Raiford found only one of his 15 cases of adenomata arising in the jejunum, while three of the 11 cases reported by Rankin and Newell were jejunal in origin. Joyce reported a case of jejunal adenoma producing intussusception. The five cases of intussusception due to polyps or glandular polyps reported by Koster[13] are presumably adenomata; it is interesting to note that three cases were in infants, four, six, and 16 months of age. The familial tendency of adenomata is noted in the cases of Haggard and Floyd and MacDermott.[14]

Postum[15] referred to 242 cases of gastro-intestinal lipomata reported in the literature; of these intussusception was a feature in 80. The cecum and ileocecal region were the sites of origin in 30 cases; 11 of these had produced intussusception.

Sarcoma of the gastro-intestinal tract is a rare condition. Boyce and McFetridge[16] state that the total number of cases reported is something over 300. It may occur at any point in the intestinal tract; however, it is more frequent in the small bowel, especially the ileum. The age incidence varies from infancy to old age, the average being about 34 years, which is about ten years younger than the average age of carcinoma. According to Ewing[17] sarcoma may arise from any mature mesoblastic tissue represented in the structure of the alimentary tract. Kasemeyer,[18] in a study of 284 cases of intussusception, found that sarcoma was responsible for 26. Intussusception was present in 14 of the 74 cases of intestinal sarcomata collected by Speese.[19] Cave,[20] in a report of 15 cases of small intestinal tumors, found an intussusception in four cases; of these, two were due to sarcoma of the terminal ileum.

Primary melanomata are decidedly rare in the gastro-intestinal tract except in the rectum, where, according to Boyce and McFetridge, they furnish two-thirds of the 100 odd cases reported. Interesting cases of intussusception secondary to melanoma of the small bowel are reported by

Lund[21] and Boyce and McFetridge. Ewing emphasizes the importance of distinguishing melanoma from diffuse melanosis of the colon, which is not uncommon in elderly persons and in those suffering from pernicious anemia.

The appended four case histories were collected from a series of 14 instances of intussusception treated on the Senior Surgical Service of Temple University Hospital over a ten year period, ending July, 1935. The remaining ten cases were of the primary type, occurring in infancy, with the exception of one child, age four, in whom a resection was necessary due to irreducibility, but no underlying tumor was found.

CASE REPORTS

Case 1.—ADENOMA OF JEJUNUM: No. 10910, E. S., a girl, aged ten, was admitted November 5, 1932, referred by Dr. M. H. Genkins. She had always been undernourished and had lived almost exclusively on a milk diet. She had suffered for 11 months from recurrent attacks of sudden colicky pains in the upper left abdomen. The attacks occurred daily and were not definitely related to meals. Some attacks were mild, with nausea lasting from one to two hours; others were severe, lasting 24 hours or longer, associated with nausea and at times vomiting, which afforded relief. The maternal grandfather had died at the age of 37 of carcinoma of the bowel. There was no familial history of similar pathology.

A roentgenologic study, October 4, 1932, showed that the transverse colon followed an abnormal course, which was thought to be due to herniation into some unusual peritoneal pocket. An operation elsewhere, October 14, 1932, failed to reveal a definite intra-abdominal hernia. The attacks had recurred after operation and the patient was admitted following a severe seizure of 24 hours' duration. She was well developed but poorly nourished. The legs were flexed upon the abdomen and she protected the lower left abdomen quadrant. A tender mass, the size of a lemon, which disappeared during the examination, was found in the lower left abdomen. There was a moderate polymorphonuclear leukocytosis.

On November 7 the abdomen was reopened. Adhesions between the omentum, intestines, and parietal peritoneum were liberated. The appendix was removed. A thick adherent splenic ledge was found. Herniation behind this was thought to have been possible. A roll of iodoform gauze was placed in the lateral splenic recess and brought out through an incision in the left flank. Thickened bowel suggestive of polyps was noted. The child complained of mild cramps after the operation which were relieved after gradual removal of the packing between the seventh and eleventh days. On the eighteenth day there was a recurrence of severe colic associated with a hard mass in the lower left abdomen. Two enemata were followed by the passage of flatus and a few bloody shreds. After three comfortable days, with natural bowel movements, she was discharged November 11, 1932.

She was readmitted December 11, 1932, suffering from another seizure which lasted seven hours. There was a palpable tumor in the left lower abdomen. She had had six attacks of severe colicky pain occurring every two days, each lasting about one hour. During these she belched and vomited clear liquid with some relief. A barium enema during an acute attack showed the colon to be normal in outline, size, and position. The mass was mesial to the descending and caudal to the transverse colon.

On December 15, 1932, the abdomen was again opened. An intussusception of 30 cm. of upper jejunum, without thickening, but markedly edematous was found and reduced by centripetal pressure. There was a small amount of plastic exudate on the upper jejunum beginning about 6 cm. below the ligament of Trietz. A resection of 20 cm. of upper jejunum with an end-to-end anastomosis was performed. The bowel contained

soft, pink, nodular projections, some sessile, others pedunculated. The surface was smooth and continuous with the mucosa elsewhere. The muscularis was not invaded (Fig. 1). The histologic diagnosis was multiple adenomatous polyps (Figs. 2 and 3).

The postoperative course was uneventful aside from a wound infection which healed by granulation. She was discharged on her twenty-third postoperative day. On October 4, 1934, she was readmitted with an abscess of the anterior abdominal wall, which was drained through the old incision. At present, three and one-half years later, she is in excellent health and has had no recurrence of her symptoms since the bowel resection.

Case 2.—Lipomata of Cecum and Ascending Colon: No. 30714, M. J., female, age 39, was admitted May 11, 1935, referred by Dr. H. C. Groff. For seven weeks she had suffered from constant pain in the lower right abdomen, which radiated upward to

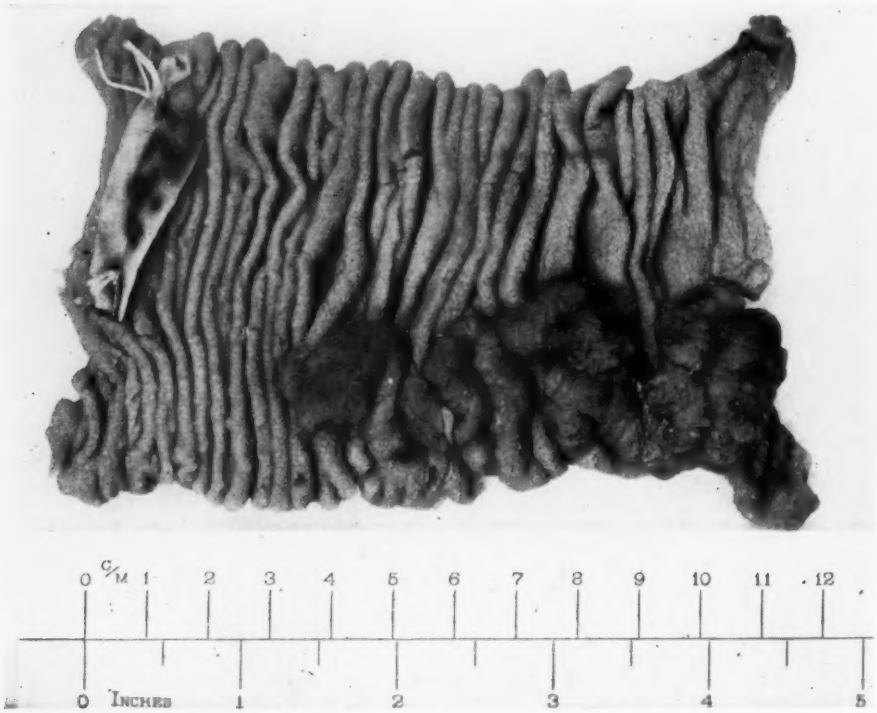

Fig. 1.—Adenomatous polyps of the jejunum. Soft, pink, sessile and pedunculated nodules extend to the muscularis.

the region of the umbilicus. At times she had attacks of acute colicky pain, worse at night, which was associated with vomiting on several occasions. There had been a gradual increase in the intensity of the pain, and the attacks of colic had become more frequent. She had been unable to eat solid foods, because they increased the pain. She had lost 17 pounds. The bowels had been variable, at times constipated and at other times quite loose. On April 26, the pain became more severe, and she noticed a lump in the right lower abdomen, which seemed to increase and decrease in size, and at times worked upward along the course of the colon. There was no history of previous similar attacks. The remaining history was irrelevant. Temperature 100° F.; pulse 98; respirations 24.

Physical Examination.—The patient appeared to have lost weight; she was not dehydrated and did not complain of much pain. The general physical examination was negative except for the abdomen. In the region of the cecum there was a movable,

somewhat elastic, tender mass about 6x5x3 cm. The abdominal wall was soft and without distention. The patient was observed for three days, during which time she had daily bowel movements, the temperature and pulse remained elevated with a tendency toward regression, and the tumor remained stationary in size and position. A diagnosis of recurrent subacute intussusception was made.

Operation.—On May 14, 1935, the abdomen was opened through a low right rectus incision. Five small pedunculated fibromyomata were removed from the uterus. The lower ileum was distended, thickened and the mesenteric nodes were enlarged to 2.5 cm. An irreducible intussusception of terminal ileum and cecum into the ascending colon for a distance of 8 cm. was found. A modified Mikulicz resection of most of the ascending colon, the cecum, and two and one-half feet of terminal ileum was performed. There was slight wound infection with skin excoriation; otherwise the postoperative course was uneventful. On the twenty-third postoperative day the spur between ileum and colon was divided between a double row of descending interrupted No. 35 alloy steel sutures, and a partial closure of the fecal fistula completed. On the thirty-fourth postoperative day the fecal fistula was liberated below the rectus sheath and closed by inverting sutures of Nos. 35 and 33 alloy steel wire; the wound was packed and allowed to heal by granulation. She

FIG. 2.—Adenoma of jejunum showing marked hyperplasia of the mucosa, and cystic dilation of tubules.

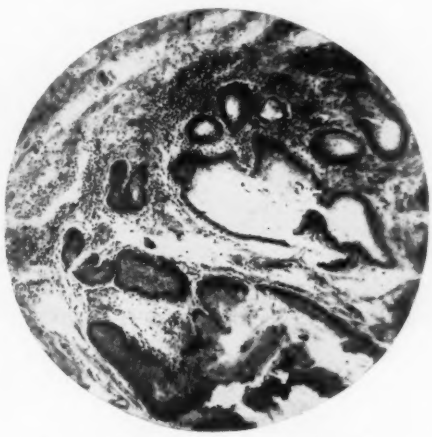

FIG. 3.—Note single layer of adult columnar cells, and lack of invasion of submucosa or muscularis.

was discharged 50 days after the operation with a healed incision. A follow up examination one year later showed fixation of the intestine to the incision with some gaseous distention in the intestines. The bowel movements were frequent and partially formed for five months, then gradually became natural in character. She gained 15¾ pounds in weight. The appetite was good and there was no abdominal pain. The pathologic diagnosis was multiple lipomata of the cecum and ascending colon with acute enteritis and lymphadenitis (Fig. 4).

Case 3.—RETICULUM CELL SARCOMA OF ILEUM: No. 28960, A. S., male, age four, was admitted March 20, 1935. Eleven days previously he had developed attacks of abdominal pain followed by vomiting. The attacks occurred day or night, and were increasing in frequency and severity. He had been able to retain only small amounts of liquids for six days. The vomitus was yellow, liquid, and contained ingested liquids. The bowels were constipated at the onset; however, movements were obtained by the use of laxatives. There had been a similar attack of abdominal pain and vomiting in November, 1934, which lasted 24 hours. The history was otherwise irrelevant. Temperature 99° F.; pulse 82; respirations 22. The development was normal and nutrition was good. The child was rational, irritable, complaining of hunger. The abdomen was soft, slightly distended, neither tenderness nor masses could be palpated, peristalsis was hyperactive. Blood Count: Hemoglobin 11.5 Gm.; erythrocytes 4,510,000; leukocytes

8,450, of which there were 3 per cent young forms, 55 per cent neutrophils, 38 per cent lymphocytes, 3 per cent monocytes and 1 per cent basophils. The urine was amber, acid, specific gravity 1,033; both acetone and diacetic acid were present.

FIG. 4.—Ileum, cecum and ascending colon showing multiple lipomata. The large sessile nodules are soft, fluctuant and characteristic of fat on section. The colon is thickened.

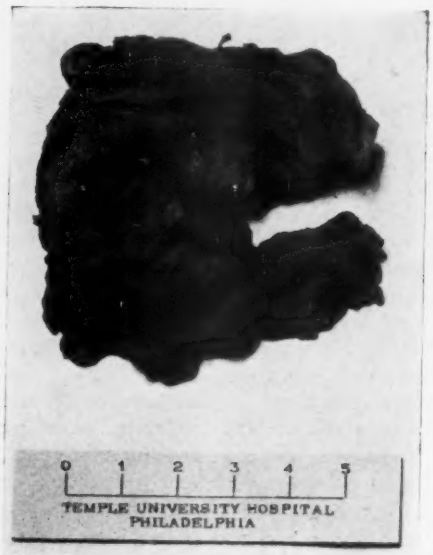

FIG. 5.—Reticulum cell sarcoma. A large soft granulomatous tumor on the mucosal surface of ileum with ulcerated edges.

After consultation with the pediatrician, a tentative diagnosis of gastro-enteritis with starvation acidosis was made. The child was treated for five days, during which time he was able to retain a soft diet, and the bowels moved once with an enema. On March 25, 1935, he was seized with acute abdominal pain following an attack of vomiting. Temperature 102.4° F., pulse 118. The abdomen became distended, with hyperactive, visible peristalsis suggesting small intestinal origin, and definite tenderness was present in the left midabdomen. At this time a diagnosis of recurrent intussusception with partial intestinal obstruction was made. An immediate operation was performed by Dr. J. N. Coombs.

Operation.—An intussusception of 8 cm. of ileum into the cecum was found, which was reduced with difficulty by distal pressure. About 5 cm. from the ileocecal valve a depressed area covered with plastic exudate and surrounding edema was revealed. The lumen of the ileum in this area was prac-

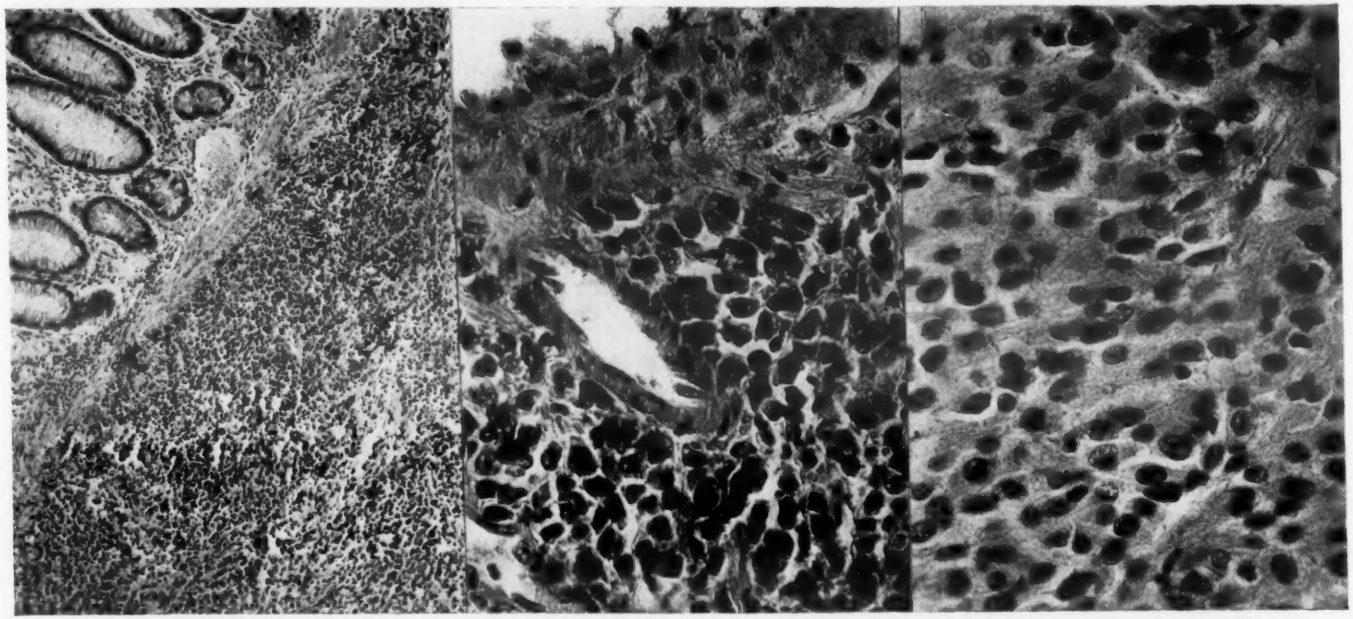

FIG. 6.—Reticulum cell sarcoma. Cellular infiltration and reticular hyperplasia.

FIG. 7.—Reticulum cell sarcoma. The cells are large, round, and irregular with compact, hyperchromatic nuclei and scanty cytoplasm. Mitotic figures in various stages (high power).

FIG. 8.—Melanoma. An area of uniform cells with large nuclei relatively poor in chromatin. Some cells contain pigment (high power).

tically occluded by a tumor. The ileum containing the tumor was resected (Fig. 5) with an end-to-end anastomosis. The pathologic diagnosis was reticulum cell sarcoma (Figs. 6 and 7). Fifteen months later, knowing the child to be still alive and free of intestinal symptoms, the diagnosis of reticulum cell sarcoma was confirmed by another pathologist.

Case 4.—MELANOMA OF THE ILEUM: No. 20927, C. D., male, age 67, was admitted to the hospital March 2, 1934. For the past nine months he had suffered from intermittent recurrent attacks of cramp-like pain radiating from both flanks to the midabdomen. The frequency, duration and severity of the pain had gradually increased. During the five days prior to admission, he had suffered at times from intense colic occurring at four minute intervals, lasting about one minute. The bowels had been constipated for years, becoming more markedly so during the past nine months. Frequently he would have no bowel movement for two to three days. Tarry stools were noticed on several occasions. There had been a diarrhea with frequent watery feces for the five days before admission. Temperature 98.4° F.; pulse 80, respirations 20. The patient did not appear acutely ill. No evidence of skin or orbital melanomata was observed. There was emphysema of both lungs, poor myocardial tone, an indirect complete right inguinal hernia, and varicosities of the veins of both legs. The abdomen was distended with some bulging of the flanks, and tenderness on slight pressure over the left side of the abdomen from the umbilicus downward to the anterior superior iliac spine was observed. Peristalsis was increased. No mass was palpated. Blood Count: Hemoglobin 11.5 Gm.; erythrocytes 3,870,000; leukocytes 8,650, of which 73 per cent were neutrophils, 16 per cent lymphocytes, 2 per cent eosinophils and 1 per cent basophils. The urine was acid, yellow-red in color, specific gravity 1,020 and a trace of albumin. He was treated by intermittent duodenal and rectal siphonage for six days without improvement.

Operation.—On March 8, 1934, the abdomen was opened through an 8 cm. upper right transrectus incision. The small intestines were dilated and thickened to a point in the ileum where an intussusception about 20 cm. long was found. The intussusception was partially reduced by pressure and the remaining nonreducible portion was resected after closure of the abdominal incision. Rectal tubes were fixed in both loops of the bowel. There was a necrotic, pedunculated, firm, dark red tumor, 3½ cm. in diameter, which arose from a thick, red, necrotic portion of the resected bowel. This tumor formed the apex of the intussusception. The serosa of the bowel over the tumor was puckered by an overlying plastic and purulent exudate. The patient died ten days later of uremia and a hypostatic pneumonia.

Histologic section revealed necrosis and a suppurative process, with only a small area of recognizable mucosa. In the submucosa, circumscribed nodules composed of solid cords and irregular masses of large cells were observed. Under high power these were found to be melanin cells, some showing granular, brown pigment. The diagnosis was melanotic melanoma (Fig. 8).

SUMMARY.—(1) It is of practical clinical importance that a primary and secondary form of intussusception be recognized, since the surgical procedure affecting a cure is dependent upon this knowledge.

(2) The relationship of intestinal tumors to intussusception has been mentioned.

(3) Four cases of intussusception due to tumors of the intestines are reported; in one, three operations were required for a cure. The tumors were: (a) Adenomata of the jejunum, (b) lipomata of the cecum and ascending colon, (c) reticulum cell sarcoma of the ileum, and (d) melanoma of the ileum.

I wish to express my appreciation to Dr. W. W. Babcock for the use of these cases.

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THE SURGICAL CORRECTION OF ANOMALIES IN FIXATION OF THE ASCENDING COLON

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IN PRESENTING any subject dealing with congenital anomalies, one must first have a thorough understanding of the normal embryologic development. McConnell[9] of Dublin has stated: "That an ascending mesocolon is as abnormal as a cleft palate." They are both the result of nature's shortcomings, failure to fuse the maxillary processes in one and failure to fuse the primitive ascending mesocolon to the posterior abdominal wall in the other.

Embryology.—In the early weeks of human embryonic life, the liver enlarges and forces the intestinal loop into the umbilical sac, producing a physiologic umbilical hernia. About the tenth week the midgut returns to the abdomen. The prearterial loop returns first (Frazer and Robbins[6]). The cecum and the terminal ileum remain in the cord and retain with them the terminal portion of the superior mesenteric artery. When the small gut returns to the abdominal cavity, the superior mesenteric artery is held forward and suspended across the cavity between its origin from the aorta and the umbilicus.

The small intestine enters the cavity on the right side of the artery. As it collects, the coils first reduced are pushed behind the superior mesenteric artery. The hindgut and its mesentery are pushed ahead, folded to the left and backward and approximate the left lateral wall. The splenic flexure is displaced further upward.

The last part of the ileum carries the termination of the superior mesenteric artery, and the last structure to be reduced is the cecum. The cecum now lies free on the anterior surface of the small intestine and is carried to the right side of the abdomen, being rotated on its long axis.

At about the twelfth week, the general mesentery becomes fused along the line of the superior mesenteric artery. This spreads out and soon the ascending mesocolon becomes fused and the colon fixed. The postarterial mesentery of the transverse colon persists except at either end—the flexures. It later fuses with the mesogastrium to form the gastrocolic omentum (Dott[5]).

"When rotation is complete and fusion perfect the ascending colon passes back into the flank at an angle of about 51 degrees. It is found that about 30 per cent of the weight of the colon is taken up by this slope. Intra-abdominal pressure sustains one-half to seven-eighths of the weight of the upper abdominal organs" (Coffey[4]).

The normally placed colon exerts traction on the posterior abdominal wall and not on contiguous organs. Its misplacement allows for abnormal

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traction. "The cecum lies in the right iliac fossa and projects downwards as a blind diverticulum. It is about two and one-half inches long and is completely invested by the peritoneum. From its anterior surface the peritoneum is continued upwards, covering the ascending colon, but from the upper part of its posterior surface the peritoneum is reflected backwards and downwards over the iliacus muscle.

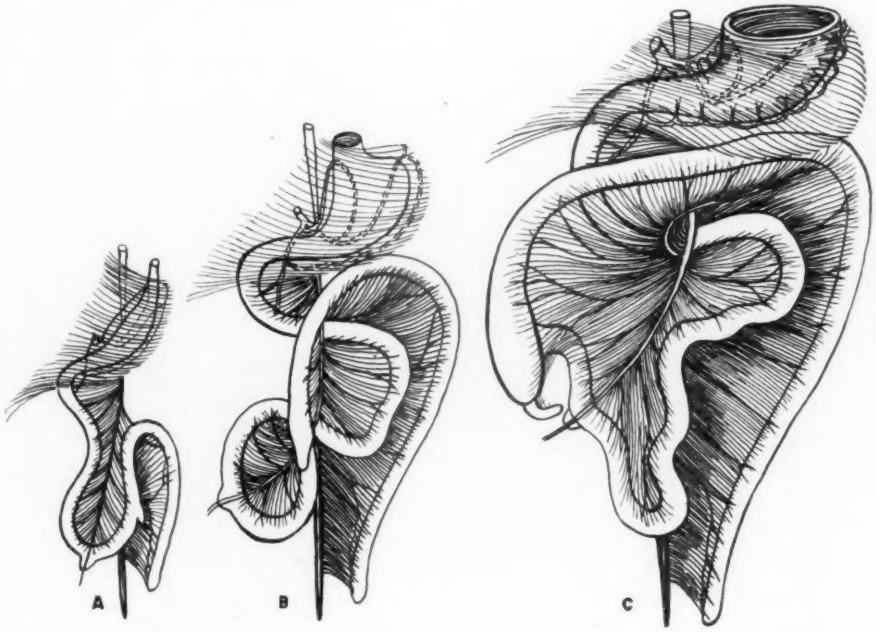

FIG. 1 (A).—Gastro-intestinal tract in approximately five weeks' embryo. Divided into foregut, midgut and hindgut. The superior mesenteric artery supplies the midgut, which is herniated into the umbilical sac. (B) At about the tenth week the midgut has returned to the abdominal cavity and has been carried to the left behind the superior mesenteric artery. The cecum is reduced last and has begun to rotate to the right side. (C) Reduction and rotation complete. The duodenojejunal junction can be seen behind the superior mesenteric artery. The ascending colon has completed its rotation and the ileum now enters it from the left side. (Small, Rouse and Patterson: The Mobile Right Colon. Texas State Medical Journal.)

"By reason of its complete peritoneal investment the cecum possesses a certain degree of mobility, but it is anchored in place by its continuity with the ascending colon, which is retroperitoneal in position. Posteriorly it is related to the iliacus and psoas muscles.

"The ascending colon extends from the cecum to the under surface of the right lobe of the liver, where it bends to the left forming the right colic flexure. It is about four or five inches long and lies in the right lumbar region, immediately lateral to the right lateral plane. Covered with peritoneum in front and on each side, but not behind, the ascending colon is fixed in position.

"Posteriorly it lies successively in front of the iliacus, the quadratus lumborum, the lumbar fascia and the origin of the transversus and the lower pole of the right kidney. At the right colic flexure, which has the colic

impression of the liver above and in front of it, the colon bends forwards, downwards and to the left, and becomes the transverse colon.

"The transverse colon possesses a mesentery and so has a wide range of movement. Posteriorly it lies first in contact with the second part of the duodenum and the head of the pancreas.[7]"

The fixed colon has a base almost equal to its diameter. It has a strong purchase from this broad attachment and all of its force and energy are exerted in forwarding its contents. The mobile colon wastes its muscular power on a thin peritoneal attachment, to say nothing of the strain and pull applied to the neighboring organs.

Any departure from this sequence of events of reduction, rotation and fixation is abnormal. The earlier it is begun the more marked the pathologic

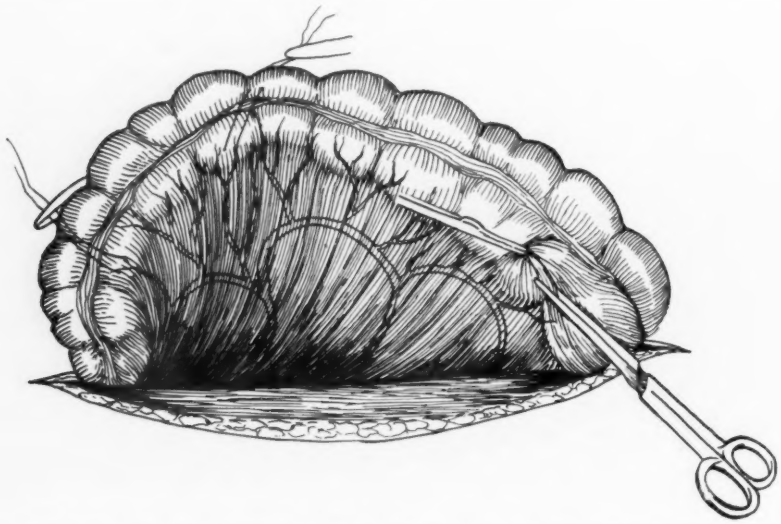

FIG. 2.—The prolapsing type of mobile ascending colon. The mesocolon has persisted in its entirety. (Small, Rouse and Patterson: The Mobile Right Colon. Texas State Medical Journal.)

anatomy, *i.e.*, nonrotation, reversed rotation and malrotation. The abnormalities produced in the third stage are: too early fusion with an undescended cecum or nonfusion with some type of coloptosis.

Anomalies.—Anomalies in fixation may be grouped into three classes: (1) Failure of the mesentery to fuse in its entirety. (2) Failure of the mesentery to fuse in part. (3) Various types of maldescent of the cecum. We are not considering those cases of non- or reversed rotation.

Class 1.—McConnell has called the first group the prolapsing type and found it in 58 per cent of his cases. Fig. 2 shows an anatomic drawing. As seen in the roentgenogram (Fig. 3), this type appears normal in the horizontal position; has from four to six inches' vertical mobility but remains straight. A distinct feature is its uniform medial mobility.

Class 2.—McConnell has divided this group into two parts; namely, the collapsed and angulated types, finding them in 3 and 31 per cent respectively.

The important feature here is that there has been fusion and fixation in some part of the colon. It may occur only in the lower part of the colon or cecum, producing a mobile upper segment or hepatic flexure. When examined fluoroscopically in the vertical position, the right flexure may fall vertically downward either anteriorly or posteriorly. This is McConnell's collapsing type. If it has a more medial excursion, it then assumes the angulated position.

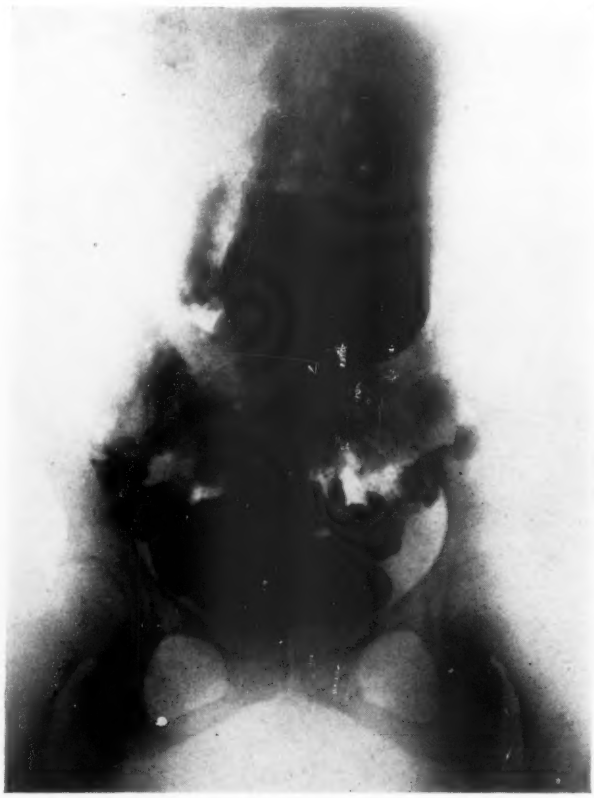

FIG. 3.—The prolapsing type as seen in roentgenogram. The cecum lies in the left side of the pelvis. The colon remains straight.

This partial fusion may occur only in the upper part, allowing free medial but not downward displacement.

Lastly, it may fuse only in the midsegment having its upper and lower ends mobile. Fig. 4 is an example of this last type. The hepatic flexure and the cecum could be lifted out of the incision and approximated.

Class 3.—Under this heading we are including those cases of so called maldescent of the cecum. The process of rotation has been complete up to this point. Because of some premature attachment, the cecum remains in the right upper quadrant of the abdomen. The ascending colon continues in

its development and passes downward anterior to the cecum. A drawing of an actual case is shown in Fig. 5.

In any type there may be found accessory bands and membranes. Ac-

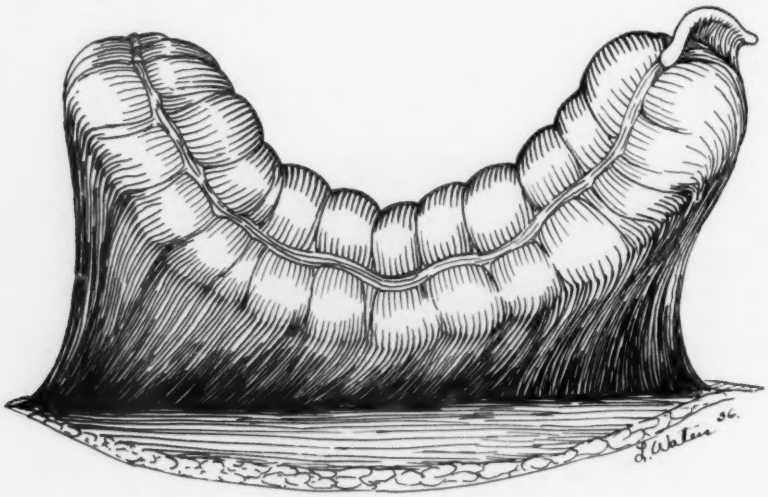

FIG. 4.—The angulated type of colon. The mesocolon has fused in the midsegment only, allowing free mobility of either extremity. (Small, Rouse and Patterson: The Mobile Right Colon. Texas State Medical Journal.)

cording to Lane as quoted by A. B. Small[12] they are "crystallized lines of force laid down in response to a strain or demand for help by supporting tissues." Adami designates them "stress hypertrophy."

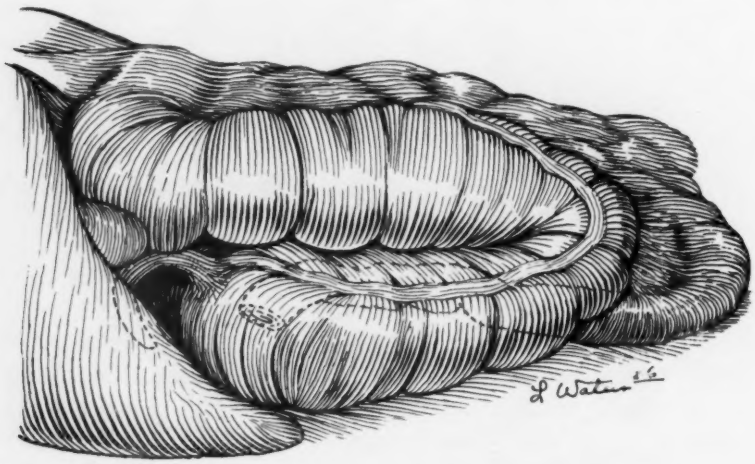

FIG. 5.—In the process of rotation the cecum has become prematurely attached in upper right quadrant. Symptoms produced by partial obstruction. (Small, Rouse and Patterson: The Mobile Right Colon. Texas State Medical Journal.)

Small says: "They are worthy of more than casual notice. They should not be incised without substituting some form of support to take their place. When massive they encroach upon the gut wall, crossing longitudinal muscular

bundles, at times reaching the root of the mesentery and have been found involving the first part of the transverse colon. Whether they remain bloodless or become vascularized they definitely hinder the functional activity of the longitudinal muscular bundles in obliterating haustral grooves prior to mass movements of the colon contents."

Coffey[4] says of these: "A pericolic membrane, no doubt in some instances, by acting unevenly does harm. When it acts evenly, however, it is a conservative process and is doing no harm in itself."

Quain[10]: "It would seem that whenever nature neglects to follow out her usual plan of fixing the colon to the right flank in early embryonic life, she makes an attempt to repair her shortcomings by introducing certain ligaments and bands to prevent or at least to limit hypermobility. Severing of these membranes produces further mobility."

Symptomatology.—The symptoms in these conditions are due to (1) obstruction, from bands or kinks, and (2) traction.

The obstructive symptoms are usually of the chronic partial variety and occur most frequently in the cases of the mobile flexure and maldescent of the cecum (Figs. 4 and 5).

The symptoms produced in contiguous structures as a result of traction are all inclusive and depend upon the particular point at which the stress is applied.

A. B. Small, in discussing Dr. Beall's paper, says "The right mesocolon serves as an housing in embryo for circulation to reach the gut wall from the superior mesenteric artery. It is poorly constructed to act as a suspensory ligament which part it must play in the event it does not become fused" (Beall[2]).

"The transverse colon depends largely on the hepatic flexure for support. When the latter is mobile it ceases to be a support and becomes partly dependent on the transverse colon which in turn drags on the gastrocolic omentum" (Coffey).

Waugh[14] has stated that the symptoms have "a constant inconstancy," and that "pain is characterized by its unusualness." Many of these individuals have long, complicated histories, characteristic frequently of nothing. Many date their symptoms from childhood, which we would expect from congenital abnormalities. Careful questioning brings out history of fits of stomach ache, cramps, nausea and vomiting as a child. Others have been constipated ever since they can remember and take either a laxative or enema every day. There may be varying degrees of pain and discomfort often referred to the right lower quadrant, which is mistaken for chronic appendicitis or mild tubal infection.

In the cases of recurring partial obstruction the patients usually have some discomfort every day, with attacks of acute pain every few days, weeks or months. They learn that a certain posture, lying on the back or right side, flexing the thighs and drawing the knees against the chest wall, will give relief. Many state that a large dose of castor oil or several

flushing enemata will terminate the attack. By posture and pressure of the thighs against the abdomen they are able to straighten the colon and force the gas or fecal current beyond the obstructed point. Sometimes an individual becomes a social recluse because of the gymnastics and contortions he has to go through to obtain relief. Obstruction from a band gives practically the symptoms as above except that they are usually more progressive, and more likely to remain so without relief. The long list of other symptoms may better be given according to organs as outlined by such authors as Carslaw,[3] Small,[12] Coffey,[4] Beall,[2] Aynesworth,[1] Longyear,[8] McConnell and Hardman,[9] and Quain.[10]

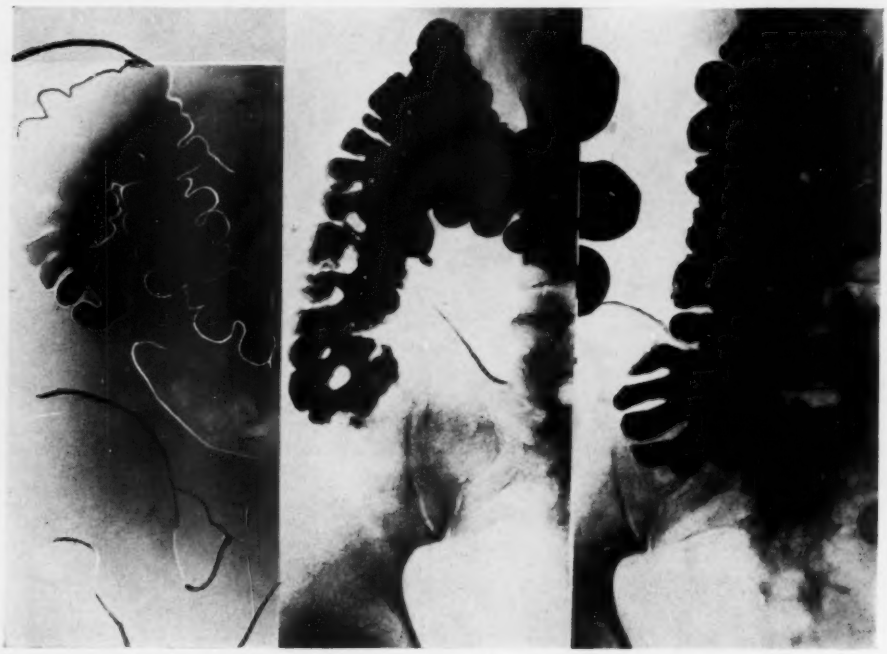

FIG. 6.—Roentgenogram of angulated type of mobile colon. On left is position of colon with patient standing. Hepatic flexure has fallen below crest of ileum. Center shows position of colon with patient prone. Note that the hepatic flexure has assumed its normal position three or four inches above crest. The third exposure demonstrates the degree of medial mobility in some of these cases. The examiner's hand has pushed the colon almost to the midline. (Small, Rouse and Patterson: The Mobile Right Colon. Texas State Medical Journal.)

(1) *Gastric.*—Carslaw, 42 cases. Previously treated for dyspepsia, gastritis; and gastric ulcer a frequent diagnosis. Pain usually epigastric, not regular, flatulence, rarely nausea and seldom vomiting. No relief by diet. McConnell reports several cases of ulcer on the lesser curvature; all had mobile colon and traction on this point.

(2) *Duodenal.*—Carslaw, 32 cases. Previously diagnosed duodenal ulcer. Pain usually in the right hypochondrium two to four hours after meals, not regular and not qualitative. Duodenum frequently dilated. Aynesworth: "With traction across the duodenum symptoms appear similar to early duodenal ulcer." Where there is duodenal dilatation the colon has more medial mobility. Pull is exerted through the right colic and superior mesenteric artery.

McConnell states that if prolapse of the colon is the cause of the dilatation, colopexy is the simpler primary procedure. Colopexy was performed in 14 cases. He also reports a case of the entire ascending colon being supported by the first part of the duodenum.

(3) *Right Iliac Fossa.*—Carslaw, 109 cases. Discomfort in the right lower quadrant, varying times and intervals. More frequent with constipation. Cecum and colon frequently dilated. Aynesworth says this is the most common type. Many have appendicectomies without relief. Difference is the freedom from pain between attacks in appendicitis. They date their trouble from early life. Small: "Too many attempts to cure by appendicectomy." Roberts[11]: "The ileocecal region yields richest rewards over the question of chronic appendicitis and he will find in these congenital anomalies the answer to much of his unsatisfactory results which have followed removal of the appendix through inadequate incisions."

(4) *Renal.*—Carslaw, six cases. "Somewhat similar to Dietl's crisis. Right kidney prolapsed." Longyear: "To consider the displaced kidney by itself, the full pathologic situation is misunderstood. To fix the kidney without regard to the colon, not only fails to give relief but frequently augments the symptoms." Aynesworth: "Pull on the right kidney, dragging sensation, weight, pain, distortions of the ureter, kinks, hydronephrosis, dysuria and frequency. Radiation along the anatomic lines of ureter, bladder and genitalia." Small: "A point which seems significant is the fact that in this series the kidney was never found movable to any extent, except where accessory bands were present (upper parietocolic)."

(5) *Gallbladder.*—McConnell. Case of mobile hepatic flexures suspended by a band to the gallbladder. Small, in 1924, reports seven cases with definite gallbladder symptoms; strain exerted along the lines of the common duct through the gastrohepatic omentum was responsible for cystic duct obstruction. Relief permanent in all following colopexy.

(6) *Acute Appendicitis.*—Aynesworth: "Not really typical, usually history of previous similar attacks, continued soreness between attacks. In older persons digestive disturbances. Some have attacks during menstrual period." Quain: "Appendicectomy gives relief for a short time because of the forced rest and diet."

(7) *Stasis.*—Aynesworth: "Nearly all have constipation."

(8) *General Symptoms.*—Asthenia, malaise, biliousness, headache, nausea, feeling of fulness, especially when constipated and on feet.

Because these congenital anomalies can assume many and varied forms and positions, the symptoms are therefore innumerable and all inclusive. A diagnosis must then be made by careful history, examination, laboratory tests and above all fluoroscopic roentgenologic studies.

The history is often vague, tedious to elicit and dates from many years back. On the other hand they may have had few symptoms until recently because their gastro-intestinal tract was able to compensate. One important

feature of the history is that the reference of pain, *etc.*, to contiguous organs is seldom characteristic of primary disease of that organ.

The physical characteristics of the individual are not always pathognomonic. Some are of the ptotic habitus with high shoulder points, low costal arches, narrow upper and wide lower abdomen. A normal healthy robust body, however, does not preclude this condition.

With the exception of direct visual and manual examination at the operating table, the fluoroscopic screen gives more information in the diagnosis. Fluoroscopists, however, must be mindful that these abnormalities do occur and produce definite symptoms.

The routine examination carried out by the gastro-enterologists, *etc.*, consists of giving the patient a barium meal the previous evening and observing him about eight hours later. This gives us valuable information regarding the progress of the barium as well as any gross filling defects. If for some reason the barium has failed to reach the hepatic flexure or has passed too far beyond that point, a barium enema is given. In the horizontal position the height of the flexure is noted as well as its general contour and curvature. The position of the cecum is likewise recorded. With the patient turned slightly to his left side, the degree of medial mobility is ascertained. Then the patient is placed in the vertical position and these same observations are made. In the average normal individual there is little if any medial excursion of the ascending colon and about two inches' vertical displacement.

The diagnosis at the operating table is relatively easy provided the possibility of its being present is kept in mind, and looked for. The colon can be brought under direct examination. The presence of a mesocolon in part or in entirety can be verified or excluded. Kinks or constricting bands may be demonstrated. To reproduce the symptom producing position, the colon may have to be manipulated somewhat. A little downward or medial traction may reveal the avenues through which this traction is transmitted to other organs.

In practically every case of a mobile or abnormally fixed colon, there is found the so called Jackson's veil or membrane, sometimes covering the entire organ. The kidney is easily palpated and if also mobile may be slipped in and out of its fossa. The extremes of any of these conditions are readily discernible, as, for example, when the entire colon can be placed high on the outside of the abdominal wall.

"These people represent a class, 90 per cent of whom are constant supplicants at the hands of the medical profession for relief; many of whom are victims of improper diagnosis and therefore improper treatment, running the gamut of surgical operations, passed on from one specialist to another, finally landing in the hands of the neurologist. As Coffey expressed, 'Many of the cases of chronic right-sided pain are treated or mistreated under the name of neurasthenia.'"

Surgical Technic.—The technic for surgical correction of these conditions is that published in 1924.[12] "Make a free exposure by shelling the

right rectus muscle out of its sheath. From six to eight small half-curved round intestinal needles armed with silk or linen are made to puncture the

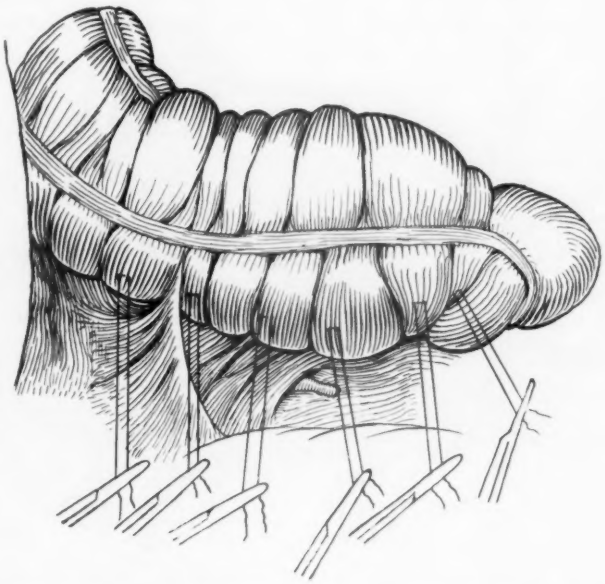

FIG. 7.—Linen or silk sutures inserted posterior to lateral muscular bundle about one inch apart. (Small, A.B.: Developmental Errors in Fixation of the Ascending Colon, Reporting One Hundred and Ninety Colopexies. Southern Medical Journal,17, 853, 1924.)

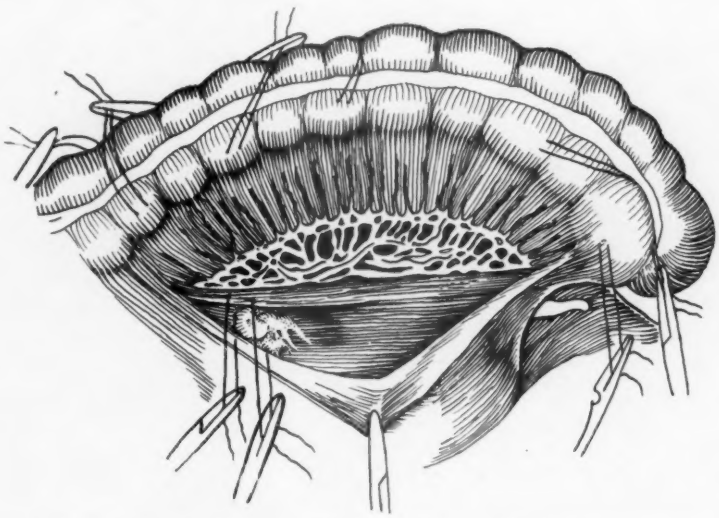

FIG. 8.—Lateral leaf of mesocolon removed. Psoas muscle exposed. Ureter and spermatic vessels held medially. (Small, A.B.: Developmental Errors in Fixation of the Ascending Colon, Reporting One Hundred and Ninety Colopexies. Southern Medical Journal, 17, 853, 1924.)

musculature of the gut an inch apart on a line about half an inch lateral or posterior to the lateral longitudinal muscular bundle (Fig. 7). Beginning

at the ileocecal segment and following whatever angulation may be found in the gut in order to keep the suture line posterior to the lateral muscle band and stopping just below the hepatic flexure. A loose nonvascular peritoneal veil or membrane is incised with scissors following the suture line, and as

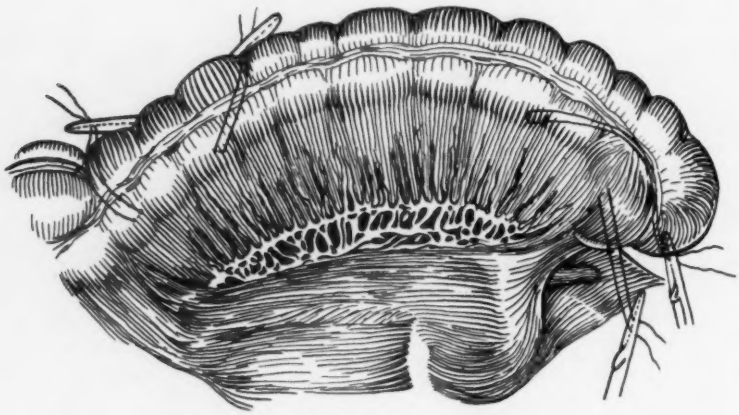

FIG. 9.—Lateral leaf of mesocolon has been sutured to psoas tendon (when present) or to psoas muscle. (Small, A.B.: Developmental Errors in Fixation of the Ascending Colon, Reporting One Hundred and Ninety Colopexies. Southern Medical Journal, 17, 853, 1924.)

the operator strips bare a superficial profuse blood supply, an assistant lifts the gut medially, exerting such traction as will keep the longitudinal muscles on a straight line. In the event that the retroperitoneal fascia has been

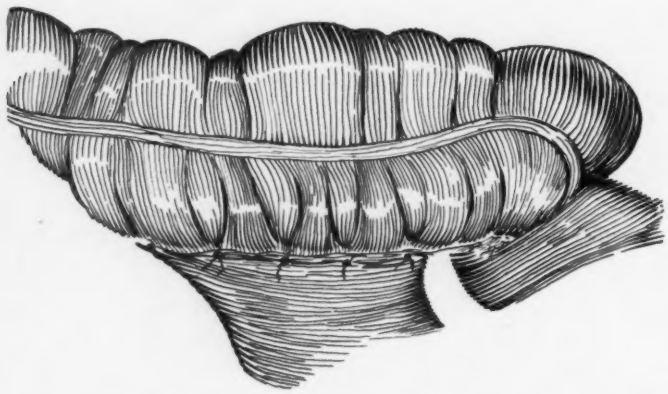

FIG. 10.—Colon now placed on its new bed and original sutures passed through quadratus lumborum and iliac muscles. (Small, A.B.: Developmental Errors in Fixation of the Ascending Colon, Reporting One Hundred and Ninety Colopexies. Southern Medical Journal, 17, 853, 1924.)

drawn away from the psoas muscle and the kidney is down, the fascia line is kept intact until the fossa is opened exposing the psoas muscle (Fig. 8). This incised fascia line is then sutured to the psoas muscle tendon (when present). If the tendon is not available the sutures are placed in the muscle

(Fig. 9). This natural floor for the gut is now vigorously wiped or scrubbed with dry gauze, producing an irritated area into the outer margin of which the sutures are placed as they are released by the assistant, beginning at the upper angle." Figure 10 shows the gut as it appears when the operation is finished with all raw areas retroplicated.

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THE FALSE "ACUTE ABDOMEN"

II. HENOCH'S PURPURA AND ABDOMINAL ALLERGY

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THE object of this paper is to emphasize the resemblance of the abdominal manifestations of Henoch's purpura and of abdominal allergy to the symptoms of certain acute abdominal diseases requiring surgical intervention, and to discuss the differential points which may be helpful in preventing diagnostic errors.

Henoch's purpura is usually described as a nonthrombocytopenic form of purpura, but this is not correct in all cases.[1, 2] The etiology of this group of diseases was suspected by Osler[3] to rest on allergic sensitivity. Since that time the conception of abdominal allergy has been evolved, and in addition Duke,[4] Landsberger,[5] Alexander and Eyermann[6] and others have shown that allergy to foods is a causative factor in certain instances of Henoch's purpura. It may be concluded that at least some of the unsolved cases of Henoch's purpura also are allergic in nature, particularly those in which there are other evidences of allergy as in several of the cases reported in this paper. The pathologic physiology of allergy is that of smooth muscle spasm and of a vascular disturbance in which there appears to be increased capillary permeability. In Henoch's purpura,* spasm of visceral smooth muscle has been demonstrated and vascular disturbances have been found in the form of purpura, visceral hemorrhage, erythema, urticaria or angioneurotic edema, depending on whether hemorrhage, congestion, or exudation occurs.[7, 8, 9] The visceral vessels, as well as those of the skin, are involved. Therefore abdominal pain varies, depending on the extent and location of smooth muscle spasm and on the extent, location and type of vascular disturbance.

The following case histories have been chosen from the records of the University of California Hospital, either because the presenting symptom was acute abdominal pain, or because they illustrate the allergic basis of abdominal attacks, or for both reasons.

CASE REPORTS

Case 1.—E. L., a white female, age 35. Her father had asthma; a brother was

* For brevity, in the remainder of this paper the term, "Henoch's purpura," is used to designate the group of related conditions under discussion without reference to the presence or absence of purpura.

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sensitive to horse dander; and a sister had hay fever. The patient knew that she was sensitive to guinea-pig hair as her contacts with these animals had caused excessive sneezing and on one occasion asthma. Contact with cat hair had long caused swelling of the eyes; and cattle hair had produced nausea, vomiting and syncope on three occasions.

In 1928, over a period of several days, she had complained of dull pain in the right lower quadrant of the abdomen which had occasionally become sharp. There had been some nausea, but no vomiting; and while no rigidity was present, there was fairly marked tenderness over McBurney's point. The white blood count ranged from 9,000 to 12,000 with 1 to 3 per cent eosinophils. There was no fever. An appendicectomy was performed; the appendix appeared normal save for a small fecolith.

Recovery was uneventful, but attacks of marked abdominal pain continued, now located in the epigastrium. They most frequently occurred in the early morning hours or shortly before the midday meal, and were often associated with severe headache. It was felt that a peptic ulcer was probably responsible for the symptoms, although roentgenograms were doubtful. A Sippy diet with rest in bed was instituted, but no relief was obtained. After three weeks in a sanatorium, the patient went abroad. This interrupted the regimen of fresh milk and cream. Nevertheless, from this time on there was great improvement in the patient's condition. During her trip abdominal pain was present only rarely, and no severe attacks occurred except once following the handling of guinea-pigs. This incident was followed by severe epigastric pain, cramps and bloody stools.

On returning to the United States in 1931, milk was again added to the diet, and severe attacks of epigastric pain returned at frequent intervals during the following year. Either peptic ulcer or cholecystitis was suspected.

In August, 1932, following a visit to an animal laboratory which she usually avoided, the patient suffered an unusually severe attack of upper abdominal pain with hematemesis and melena. The summary obtained from the hospital she entered at that time indicated that there were marked tenderness and moderate rigidity in the epigastrium. Perspiration was profuse, and the patient appeared to be in shock. The temperature was 38.2° C., and the white blood count was 10,400 with 88 per cent polymorphonuclear cells and 2 per cent eosinophils. A few hours later the white count had risen to 17,300. A tentative diagnosis of perforated duodenal ulcer was made. While preparing the patient for operation, a large urticarial wheal was noticed in the left upper quadrant. No pathologic condition was found at operation. The epigastric pain returned during convalescence, at which time the differential count showed 4 per cent eosinophils. Allergy was now suspected, and scratch tests showed positive reactions to milk, egg, guinea-pig hair and cat hair. Avoidance of these factors resulted in complete relief from the abdominal pain and headaches. It was now clear why the patient improved when the Sippy diet was discontinued. At present, if the patient drinks milk or eats cheese these symptoms still return.

Case 2.—J. D., an American woman, age 31, had suffered since childhood until the age of 14 from recurrent attacks of abdominal pain and vomiting. All her life she had been subject to urticaria, hay fever, and hemorrhagic manifestations such as petechiae, epistaxis, bleeding from the gums, and profuse hemorrhage from small cuts. The patient's bleeding time had on many occasions been found to be moderately prolonged, once up to 15 minutes.

At the age of 23 she had an attack of arthritis. A month later she had an obscure illness during which an exploratory operation was performed which revealed no abnormalities except edema of the gallbladder confirmed by biopsy.

At the age of 30 the patient was awakened one night by a severe, sharp, epigastric pain referred to the back and associated with intense nausea, profuse salivation and drenching perspiration. This pain was somewhat relieved by drawing up the knees and by hot applications, but it persisted with remissions and exacerbations for several hours. Epigastric distress, nausea, and upper abdominal tenderness persisted for several

days. The blood, urine, cholecystography and gastro-intestinal series were all found to be negative.

Six months before her last hospitalization, at the age of 31, the patient began to have frequent attacks of abdominal pain similar to that described above, although most of them were less severe. For a while tincture of belladonna in large amounts was found to decrease the frequency and to lessen the severity of these attacks. The attack for which she entered the hospital failed to respond to 2.5 cc. of tincture of belladonna, but each of three injections of atropine gave spectacular, although only temporary, relief.

Physical examination showed hyperesthesia over the abdomen, general abdominal tenderness, rigidity, and bilateral psoas spasm, all more marked on the right side. The patient found it less painful to lie on the right side with knees tightly drawn up. Any use of the abdominal muscles caused extreme pain. Temperature, 38° C. The urine was negative except for the presence of acetone and a faint trace of urobilin. Examination of the blood showed 11,560 leukocytes with a normal differential count. Roentgenologic examination of the abdomen was negative.

An exploratory operation on the day of entry disclosed small whitish papules on the visceral peritoneum which were especially numerous over the appendix. The appendix was removed, and the patient made an uneventful recovery. On microscopic examination, the appendix showed edema of the subserosal tissue. Following appendicectomy, the attacks of abdominal pain continued for a while with undiminished severity. Later, skin tests revealed sensitivity to several foods, including wheat; and with elimination of wheat products, the attacks have occurred only rarely and in a mild form.

Case 3.—E. N., an English woman of 43, was admitted to the hospital for constant, dull, upper abdominal pain referred to the back accompanied by episodes of attacks of cramps. These cramps started in the upper abdomen and later in the attack spread throughout the entire abdomen. At the time of onset nine months before entry, when her pain was chiefly in the right upper quadrant, she had been operated upon for cholecystitis; the findings were negative and the gallbladder was not removed. While in the hospital she was observed in four acute attacks, during which the pain was mostly in the left upper quadrant. She had tenderness under the left costal margin, but no spasm of abdominal muscles. There was only slight fever and no leukocytosis. The eosinophil count was 2 per cent. On entry, the patient had a purpuric spot on the thigh. One of her attacks while under observation was accompanied by giant urticaria, and another by marked erythema of the face. Angioneurotic edema of the hand was observed between two of the attacks. Injections of epinephrine afforded relief in two abdominal attacks, and failed to help in one. There was no history of allergy in the family, but for the past 12 years the patient herself had suffered intermittently from angioneurotic edema, urticaria, and hay fever. A diagnosis of allergic rhinitis was made by the consulting otolaryngologist. The following diagnostic procedures were all negative: Urine analysis, cultures of the kidney and bladder urine; phenolsulphonephthalein test; Wasserman and Kahn reactions; sedimentation time; lumbar puncture; examinations of the stool; roentgenologic investigation of the teeth, kidneys and the entire gastro-intestinal tract; and scratch tests to foods, household inhalants and bacterial extracts. About a year after discharge, following a cholecystectomy and gastro-enterostomy performed for duodenal ulcer, the patient died in another hospital.

Case 4.—E. J., an Armenian, age 26, had begun to suffer at the age of two from attacks of severe abdominal cramps which had doubled him up. Until the age of 15 years, these had come on about four times a year; and since then had occurred approximately once a week. The attacks, which were about six hours in developing, usually lasted one to two days, occasionally as long as a week. The pain, which in the earlier attacks started in the right shoulder but later began anywhere in the abdomen, was at onset dull and aching; and became cramp-like and stabbing as it spread throughout the

abdomen and to the back. High fever, severe headache and vomiting accompanied the attacks. There was no family history of allergy, but a younger brother had similar attacks (see Case 5). For several months at the age of 20 the patient had hematuria following his attacks. He had had 13 previous hospital entries for this condition without obtaining a diagnosis or relief. Reports from some of the hospitals where he had stayed, which include several teaching institutions, state that "every possible laboratory test, including inoculation of blood into a monkey, was negative"; that an eosinophilia of 14 to 24 per cent was found; and that appendicectomy, splenectomy, and biopsy of an inguinal lymph node had been performed without definite pathologic findings.

The patient was observed by us in four attacks. In these, marked tenderness and spasticity of the abdomen were noted, more pronounced on the left. Medication with various sedatives was of no avail; but an injection of epinephrine relieved the sharp pain for several hours on two occasions, although it was ineffective on a third. On several occasions a few purpuric spots were seen. The maximum temperature was 39.6° C. Leucocytes numbered from 17,250 to 27,350 with eosinophils up to 3 per cent during attacks, and were normal between attacks. During attacks the urine contained a heavy trace of albumin. The icterus index was 17. The Rose Bengal liver function test indicated moderate impairment of function. The following laboratory procedures were essentially negative: Blood and urine cultures; examinations for filaria and trypanosomes; Wassermann and Kahn reactions; blood non-protein nitrogen test; examinations of the stool; lumbar puncture; scratch tests to food, animal epidermals and household inhalants; and roentgenologic examinations of the chest, abdomen, gallbladder and entire gastro-intestinal tract.

Case 5.—C. J., an Armenian male, age 24, had suffered since the age of four from attacks of severe abdominal pain occurring about every four to six weeks. Of later years these episodes had occurred at weekly intervals. At the time of onset of an attack, which he could predict, the patient was nauseated and had a severe headache. He had dull pain which started usually in the right shoulder, and became more severe as it passed to the abdomen. The abdominal muscles became forcefully contracted, and there was great tenderness on the slightest pressure. He preferred to lie on his back, with the legs drawn up. A chill usually occurred, followed by a temperature rising at times to 39.5° C. Vomiting ensued sooner or later, and was very painful but relieved the patient somewhat. Following the attack there was diarrhea and passage of dark urine. After an attack he felt unusually well for several days.

Between the ages of 11 and 20 the patient had had periodic episodes of painful swelling of the knees and ankles, sometimes accompanied by redness. These attacks had occurred four to five times a year, lasting from a few days to two weeks. There had been no known allergy in any member of the family, but an older brother had similar attacks (see Case 4). The patient had had many diagnostic studies, but all were negative. Once he was scheduled for splenectomy at another hospital but the operation was not performed because his brother, after removal of the spleen, had had a recurrence of his attacks.

The patient was seen by us in four attacks during which abdominal hyperesthesia, tenderness and rigidity, all more severe in the lower abdomen, were noted. In two attacks petechiae on the extremities were observed, and in another purpuric spots over the abdomen. Sedatives and analgesics had no effect; adrenalin gave partial relief on one occasion but was ineffective on another. During the attacks the leukocytes were between 15,520 and 19,240, with eosinophils up to 7 per cent, and were normal between attacks. The urine showed the faintest possible trace of albumin. The stools were liquid, but were otherwise normal. The following laboratory procedures were essentially negative: Blood culture; blood urea test; Wassermann and Kahn reactions; phenolsulphonepthalein test; cystoscopy; and roentgenologic examination of the chest, kidneys, and the entire gastro-intestinal tract.

Case 6.—R. A., an Armenian man, age 29, had had in early youth episodes of abdominal pain and vomiting which occurred during the fruit season. Seven years ago he began to have attacks of pain starting in the epigastrium and extending to the right upper quadrant of the abdomen and, in a lesser degree, to both flanks and lumbar regions. Chills, fever up to 39° C., headache, and stiffness of the joints, accompanied the pain. During an attack the patient's abdomen became rigid and was very tender. Large erythematous macules appeared on the abdomen and elsewhere over the body. At the height of the attack vomiting occurred followed by some relief. Later there was sometimes diarrhea, and following an attack the patient passed dark urine. He usually had several attacks about eight days apart, followed by a period of well-being lasting from four to six weeks, after which another series of attacks began. During such a series the patient lost about ten kilograms in weight, which he regained later. Nervous irritability and abdominal distention preceded by several hours the onset of attacks. His mother and a cousin had suffered from hay fever. He had had an appendicectomy without benefit. Three years before entry he had a thorough diagnostic study at another teaching hospital where cervical and axillary lymphadenopathy, and splenomegaly were found. At this time he had had a leukocytosis up to 24,350 with 2 per cent eosinophils. The following laboratory procedures had been negative: Urine and blood cultures; agglutinations for organisms of the undulant fever group; and roentgenologic examination of the genito-urinary tract, gallbladder and entire gastro-intestinal tract. About a year before entry a physician had kept the patient free from attacks for nine months by the use of increasing amounts of belladonna, but at the end of that time they had recurred in spite of this treatment.

The patient entered the hospital for a diagnostic study and had no attacks while under observation. The physical examination was essentially negative; the spleen was not felt. Blood counts, Wassermann and Kahn reactions, urine analysis and stool examinations were negative. The icterus index was 14. Intradermal skin tests were questionably positive for many foods from unrelated groups. He was discharged with the recommendation to omit the foods to which he showed positive skin reactions, but this dietary restriction did not prevent the recurrence of his attacks.

Case 7.—J. K., an American boy, age four, was admitted to the hospital with generalized fading purpuric spots which had appeared ten days previously following an upper respiratory infection. There were subcutaneous hemorrhages of various sizes over his arms, buttocks and legs; and the patient showed marked dehydration with cracked lips and sore gums. The abdomen was negative, and the temperature was normal. A trace of albumin in the urine and a leukocytosis of 17,000 without eosinophilia were present. Three days after entry, orange juice was taken for the first time in the hospital. Thirty-six hours later the patient's abdomen became markedly distended and diffusely tender. Fresh petechiae appeared on the abdomen, back and extremities. The patient vomited and passed a dark stool which was strongly positive for occult blood. The temperature remained normal.

The patient's mother said that the patient had had numerous attacks of urticaria, and that he disliked orange juice, egg-white and milk. A sister of his vomited and had hives whenever she ate grapefruit; otherwise the family history was negative for allergy.

Scratch tests with food proteins were negative, but a one plus reaction to orange was obtained consistently by the intradermal method. However, orange juice as an etiologic agent of the purpura was questioned; and a few weeks later, after all symptoms had subsided, it was given again. Within 24 hours there was a shower of petechiae, marked abdominal distention, pain and melena. A third trial gave identical results.

Two weeks later the patient accidentally ate mayonnaise with raw egg-white in it. A day later he complained of abdominal pain, and a crop of purpuric spots appeared.

Case 8.—M. M., a white male, age three. A brother had asthma. When the patient was two and one-half years old his left knee and the dorsum of his feet and hands swelled, and purpuric spots appeared on his buttocks, scrotum and extremities. The rectal temperature was 38° C. Platelet counts were normal. Swelling of the eyelids ensued, and three days after onset he vomited blood-tinged material and complained of severe colicky pains in his abdomen. The following day the vomitus was coffee-ground in appearance, and the stools were tarry. During the next week, fresh purpuric spots appeared daily; and red blood cells, albumin and casts were found in his urine. He complained of pain in the joints. The edema of the dorsum of the hands and feet gradually subsided but the urine continued to show red blood cells and albumin as long as eight months later.

DISCUSSION.—The anatomic basis of the abdominal manifestations of Henoch's purpura is spasm of smooth muscle, which probably causes the colicky type of pain; and local infiltration of the bowel with blood or serum, which is probably responsible for the constant pain. In Case 2, operation revealed small whitish papules scattered over the intestine and appendix: a veritable peritoneal urticaria. On pathologic examination of the appendix, nothing but local edema was found to account for this appearance which at first suggested tuberculous peritonitis. Of 12 published cases of Henoch's purpura,[10, 11, 12, 13] operation disclosed in seven instances, small and large hemorrhages in the visceral peritoneum of the intestine; and in five instances, edema involving the intestine or stomach. The ileum is the part of the bowel found to be by far the most frequently affected.

The clinical manifestations of Henoch's purpura, which in severe attacks may simulate an "acute surgical abdomen," are pain, vomiting, abdominal distention, spasticity or rigidity of abdominal muscles, fever, and leukocytosis. The pain is usually dull at first, but later becomes colicky and may be extremely severe. Nausea and vomiting occur in most cases. Spasticity of the abdomen is usually present during severe attacks, and actual rigidity may also be found. As is shown in several of our cases, fever can be high; and the leukocyte count may reach 27,000.

The clinical picture of an attack of Henoch's purpura with abdominal manifestations in most cases includes certain features which help to differentiate it from that of abdominal sepsis. The most common of these is the absence of an evident cause for the abdominal symptoms, which should put the surgeon on his guard. Most striking when present are the cutaneous and joint symptoms. When they are absent, a history of such symptoms must be sought because, although abdominal symptoms, skin lesions, and arthralgia are all characteristic of the disease, unfortunately these phenomena often occur not simultaneously but in sequence.

Once suspicion of Henoch's purpura is aroused, some of the following peculiarities may be noted in regard to the abdominal symptoms. The patient will have had similar but perhaps less severe attacks in the past, often starting in childhood with possibly an intermission of several years. The attacks often occur at regular intervals, may be preceded by prodromal phenomena,

and frequently last only a day or two. The pain may start outside the abdomen, for example in the shoulder, later becoming abdominal. Also, the pain may have a tendency to shift from one part of the abdomen to another, either during the same attack, in which case the shift is usually from the upper to the lower abdomen; or from one attack or series of attacks to the next, in which case the shift may be from right to left or vice versa. Often the patient complains in addition of marked unilateral or bilateral lumbar pain. Attacks may be accompanied or followed by diarrhea, with or without bloody stools, and by hematuria.

On physical examination, the spasticity of the abdominal muscles is often less pronounced than the severity of pain and the degree of tenderness would lead the examiner to expect. The spleen may be enlarged. Fever, although often high, may be slight or absent.

Among laboratory procedures, the white blood cell and differential counts are of considerable value in differential diagnosis: (1) When a definite eosinophilia (over 4 per cent) is present; (2) when, as often is the case, the polymorphonuclear neutrophils are not increased in proportion to the degree of leukocytosis; or (3) when, as occasionally occurs, the total count is normal. Analysis of the urine in many instances shows albuminuria and gross or microscopic hematuria usually present only during attacks except in late cases in which true nephritis has resulted. Gross or occult blood is frequently found to be present in the stools.

We found that epinephrine and atropine considerably ameliorate the abdominal symptoms of Henoch's purpura on many occasions when sedative and analygesic drugs, sometimes even morphine, have failed to relieve the pain. This effect is consistent with the allergic basis of the disease which has been demonstrated in many patients, and with the fact that spasm of smooth muscle plays a part in the production of the abdominal symptoms.

Since the allergic constitution is often an essential feature in Henoch's purpura, in dealing with this disease we should be familiar with the characteristics peculiar to the allergic individual.

First, he is likely to have a positive family history for asthma, eczema or hay fever (vasomotor rhinitis). Members of the immediate family are of most concern in determining a familial tendency; and asthma, eczema and hay fever are more reliable indications of allergy than are transient hives, migraine, or vague intolerance to foods. On questioning the patient, asthma should be inquired for in terms of "recurrent coughing and wheezing"; eczema as a "chronic itching rash, especially at the knees and elbows"; and hay fever as "excessive sneezing either seasonal or nonseasonal." There are many individuals who dislike or who do not know the correct terminology for these conditions.

Second, the allergic individual often has a personal history of these allergic disorders, or of definite food intolerances such as the repeated vomiting of egg-white in infancy. At times the patient well knows the nature of his

sensitivity, and states that eggs, wheat or milk, cat-, dog- or horse-dander, house dust, or some other well known allergen is responsible for certain symptoms.

Third, eosinophilia, if it is present, is of considerable diagnostic value. However, its absence should by no means rule out the presence of allergy. We know that in the same individual eosinophilia may be present at one time and not at another.

Unfortunately, a fourth characteristic of the allergic individual—the ability of his skin to react to the offending substance—is by no means always present. Especially in food allergy is it apt to be absent. Thus far the proven causes of Henoch's purpura have been primarily foods, so it is not surprising that the skin tests are at times negative. In Case 7, repeated intradermal tests showed a negative reaction to two offending foods (egg and raw milk), but a slight though definite reaction to one (orange). Therefore carefully administered trial diets may be necessary in the search for a food allergen which is responsible. Recent reports[2] indicate that occasionally drugs should also be investigated as a possible cause of Henoch's purpura.

The difficulty of recognizing Henoch's purpura, especially when skin lesions and arthralgia are absent, is shown by the frequency of mistaken diagnoses with consequent operations on patients with this disease. This prompted Pratt[14] to state that "no one should operate on a child with abdominal colic until the diagnosis of Schönlein-Henoch's disease has been excluded." Of the six patients described above who had abdominal pain as their presenting symptom, four underwent two celiotomies each for this condition; one was operated upon once; and one narrowly escaped operation because his brother, who had just had a splenectomy for similar attacks, suffered a recurrence a week after operation.

Unfortunately, recognition of Henoch's purpura in a given case does not end the problems encountered in handling a patient with this disease. In a small number of cases the swelling of the bowel incident to edema or hemorrhage causes intussusception; or, very exceptionally, necrosis of the affected portion of the gut results in perforation. Both complications, needless to say, require prompt surgical intervention. The resemblance of symptoms of uncomplicated Henoch's purpura to those of primary intussusception, and the possibility of secondary intussusception, lead to the necessity of making a careful differential diagnosis.

The following points may be helpful in diagnosis: Four out of five patients with intussusception are under two years of age, whereas Henoch's purpura may occur at any age. Abdominal tenderness and spasm, which are often found from the time of onset of pain in Henoch's purpura, rarely occur between attacks of colic until 24 hours or more after onset in intussusception. Vomiting of blood is practically never seen in intussusception, but may occur in Henoch's purpura.

Severe and persistent tenesmus is a very important symptom of intussusception, and is usually absent in Henoch's purpura. On physical examination

a characteristic sausage-shaped tumor, situated as on the arc of a circle with its center at the umbilicus, is almost always present in intussusception. If such a tumor is lacking in suspected intussusception, pinching or slapping the abdominal wall will often initiate a colic with the resultant appearance of the tumor described above. In other cases, it may be discovered by palpation in a tub of hot water or under anesthesia. If the same symptoms appear in a patient with Henoch's purpura, secondary intussusception must be considered. In uncomplicated cases of Henoch's purpura an abdominal tumor caused by hemorrhage or edema may be found, but it usually lacks the shape and orientation characteristic of the tumor found in intussusception.

With these features in mind, it is possible in most cases to recognize Henoch's purpura without overlooking the possibility of rare complications which require surgical intervention. In doubtful cases, the risk of a useless celiotomy for an attack of Henoch's purpura should be balanced against the danger of withholding proper surgical treatment from a patient with a true "acute abdomen." In dealing with a disease in which the symptoms are as complicated as they are in Henoch's purpura, errors in diagnosis and in therapeutic judgment are bound to occur, but they can be minimized by keeping in mind this condition and by adopting a conservative attitude when a diagnosis of Henoch's purpura seems likely. One should remember that in Henoch's purpura, recovery from an attack of severe abdominal pain is the rule, whereas the incidence of complications which require surgical intervention is very low.

SUMMARY

(1) Eight cases of Henoch's purpura and of abdominal allergy are reported. Six of these patients had acute abdominal pain as the presenting symptom, and at various hospitals had undergone nine abdominal operations for their attacks.

(2) The distinguishing features of the clinical picture and laboratory data in Henoch's purpura are discussed.

(3) The characteristics of the allergic individual are described.

(4) Intussusception as a rare complication of Henoch's purpura requiring surgical intervention is considered.

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FORESKINS AS SKIN GRAFTS*

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OF THE methods now used to cover over large denuded areas, none is simpler than the use of circumcised prepuces. In any hospital having an active maternity service, one may obtain all the foreskins necessary. These are usually discarded, however, if desired as grafts, and if not required immediately, they may be kept in physiologic saline solution in a refrigerator, or may be imbedded in ice cubes. It is possible to keep such foreskins for several days and successful results have been obtained with prepuces that have been kept in the ice box in saline or ice cubes for as long as two weeks.

Although it is generally conceded that autografts are more satisfactory, isografts, such as foreskins, succeed in so large a percentage of cases that they are well worth employing, as excellent results may be obtained. There is much difference of opinion as to the usefulness of isografts. McWilliams[1] states that he had never had any success with isografts and "that reports of success with this type of graft may be relegated to mythology." Our experience with the use of prepuces definitely refutes his contention for about two-thirds of the foreskins transplanted "took" satisfactorily. Nevertheless the vast preponderance of opinion at present is that permanently successful results are never obtained with isografts. In most of the cases reported in the literature, the grafts "took"; that is, they adhered and remained in place for a variable number of weeks but ultimately became detached and sloughed off.

It has been suggested by those who have obtained satisfactory "takes" with isografts that when the blood of the donors and recipient shows isoagglutination, favorable results are obtained. Neuhof,[2] Shawan[3] and others report successful grafts when the donors of the grafts were selected on the basis of blood compatibility. On the other hand, there are others who insist that skin grafting between two persons is never successful even when the donors selected cross match with the recipient, except possibly if the skin is grafted from one identical twin to the other. That the blood groups may play a part in the success of isografts is probable when we realize that group specific substances are present in practically every tissue of the body. However, they are not the sole deciding factor. It is known that skin near mucocutaneous junctions grows well and heals well. Kubanyi[4] has demonstrated from his experimental and clinical work that isoplastic transplants "take" better when infant or embryonal tissues were used. McNealy in discussing a paper by Padgett,[5] in which homografts were declared to be

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impractical and always doomed to failure, cited a case that had come under his care, which had been treated previously elsewhere, of a man who had been badly burned. After granulation had occurred, skin grafting was begun. The first grafts were made of prepuces from recently circumcised children. These grafts grew well. After four or five such grafts had been applied, the previous surgeon decided that it would be too tedious to wait for enough material, and decided to use transplants taken from a nephew. One week after employing these new grafts the patient was again transferred to Doctor McNealy's care, and two weeks after the transplantation of the skin of the nephew, the patient developed a typical allergic reaction. Locally the grafted area became hyperemic and swollen and after a few days those grafts which had been taken from the nephew began to separate and gradually melted away. Curiously enough, the foreskin grafts continued to grow vigorously. However, all subsequent grafts were taken from the patient himself. This is the only reference found in the literature of foreskins used as homografts. There are several reports describing their use as autografts, the most recent of which is the case reported by Dr. Jacob Sarnoff[6] of a young boy who had caught a ring on his fourth finger on one of the spikes of a fence. The weight of his body tore off the ring with the skin of his finger, together with the nail. The boy was circumcised and the foreskin grafted over the raw surface of the finger.

TECHNIC.—Our method for grafting the foreskins is quite simple. In view of the prevailing conflicting opinions as to the value of blood group compatibility between the donor and the recipient, neither the patient nor the infants were "typed." All the foreskins that were available were used. If the prepuces could not be used immediately after circumcision, they were put into normal saline solution and kept in a refrigerator until they could be used. About 90 per cent of the foreskins that we transplanted were preserved in this manner before they were used. Grafting was not attempted until healthy, firm granulations were present. At the time the transplanting was actually done, warm saline solution was poured into the jar holding the chilled foreskins to gradually raise their temperature, the excess solution being poured off and more warm saline added until the prepuces approximately reached body temperature. The mucosa was dissected from the skin and discarded, because it was destroyed in the dissection of the preserved specimens. Using the fresh foreskin, the mucosa is not destroyed in the dissection, and can be used as well as the skin. The skin was then placed in warm physiologic saline while the denuded area was prepared for the transplant. The granulations were cleansed with normal saline only. Exuberant granulations were either curetted or removed with curved scissors or a sharp knife. Bleeding was controlled by pressure with gauze before the foreskins were applied. It is quite important to completely stop all bleeding, for collection of blood beneath a graft will cause it to die. This becomes apparent when one remembers that a graft is parasitic and must exist upon

absorption of tissue juices or lymph during its first two or three days of existence. Hence its intercellular spaces must be open to the circulation of lymph in order that nourishment may be carried to its cellular elements. Whole blood cannot accomplish this requirement and hence, any collection of blood beneath a graft is to be guarded against. After the bleeding was completely controlled, the prepared foreskins were placed with their raw surfaces upon the granulating surface at short intervals and then covered with a strip of porowax large enough to cover over the denuded area. Sterile dressings were placed over the porowax. The dressings were not disturbed for four or five days, when the grafts were examined. Using this simple method, in the cases herein reported, approximately 19 out of a total of 27 foreskins, in one case, and two out of four in the other case, "took" satisfactorily. They grew well and fused with one another and with the edge of the denuded areas.

There are innumerable indications for skin grafting and foreskins could be used in practically all of them to cover over the raw areas. Not only can they be used where thin skin is required, but also where thick skin has been destroyed, *e.g.*, on the sole of the foot, as in the case here reported, for the general tendency is for any graft to take on the characteristics of the skin in its new location. Thus the skin of the graft eventually becomes more like that of the skin surrounding the denuded area, thin skin becoming thicker and thick skin becoming thinner. Skin grafting finds its greatest usefulness in cases where the skin has been destroyed by some traumatism or by severe burns. Grafts might be used for chronic ulcers and to cover over amputation stumps. Using foreskins for the grafts should be well worth trying in such cases. Prepuces should make excellent grafts for plastic work on the eyelids.

CASE REPORTS

Case 1.—No. 36-362, Wyckoff Heights Hospital. A boy, age seven, was admitted January 31, 1936. His right foot had been run over by a train. There was complete avulsion of the skin of the plantar surface of the foot, the back of the heel and from the sides of the foot below the internal and external malleoli, exposing muscles, tendons and blood vessels. Roentgenologic examination showed a fracture of the second and third metatarsals; fracture of the second phalanx of the great toe; fracture of the first and third phalanx of the second toe; and dislocation of the third, fourth and fifth toes. The skin that remained on the foot soon became gangrenous and sloughed. With the slough was separated the distal fragment of the second phalanx of the great toe, the second toe beyond the fracture in the first phalanx and the third, fourth and fifth toes. Wet dressings of saline were used until all the infection had been controlled and granulations had formed. Grafting with the foreskins was begun March 15 (six weeks after admission). On that day three foreskins were employed that had been imbedded in ice cubes. Of these, one "took." The foreskins subsequently used were preserved in physiologic saline in the ice box except for two that were used fresh. On March 19, four foreskins were used. Of these, three "took." On March 24, four were used, two "took." On March 31, three were used, three "took." On April 7, three were used, two "took." On April 11, three were used, two "took," and on May 9, three were used, and three "took." While the foreskins were being transplanted, the big toe began to turn inward so that the bottom of the foot looked like the letter C. When

the grafts seemed firmly attached, a splint was placed at the outer side of the foot and bandaged to the foot in an attempt to straighten it. This was partially accomplished, but the pressure of the splint produced two necrotic areas about one-half inch in diameter, which required four weeks to heal. The remaining time that the boy was in the hospital was devoted to limbering up the foot and reeducating him to walk. At present the foot is entirely covered by apparently healthy skin. The boy walks quite well considering the loss of the three lateral toes and parts of the two medial toes. He uses an ordinary shoe.

Case 2.—No. 36-3693, Wyckoff Heights Hospital. A girl, age 14, was admitted with oblique fractures of the radius and ulna of the left forearm. These were reduced and traction maintained by using a metal splint. Pressure necrosis of the skin occurred at the base of the middle finger of the hand. When the ulcer healed, the finger became markedly flexed and could not be extended. The scar tissue was excised and the finger kept in extension with a splint. Foreskins were used to cover over the denuded area. The first two that were used did not "take," but the two that were used subsequently "took" satisfactorily.

We do not dispute the superiority of autografts over isografts. Nevertheless our experience with the use of prepuces has convinced us that they are well worth using. The fact that the technic is simple and requires no elaborate preparation should make this type of skin grafting a method of choice. When foreskins are used the patient is not left with scars in other parts of his body. Anesthesia can usually be dispensed with for there is comparatively little pain associated with the curettement of exuberant granulations. Practically all of the operative procedures in these cases were accomplished in the ward. The objection might be raised that not enough foreskins may be available at all times. This is quite true. However, if the supply at the hospital is insufficient, arrangements may be made with other hospitals.

Although all our failures were from preserved foreskins, it is very likely that if we had used more fresh prepuces (we used only two) we would have had failures with them, too. Nevertheless we suggest that all foreskins available be saved and not discarded, but be imbedded in ice cubes or in saline for future use. The ice cubes should be thawed out slowly when the foreskins are to be used. To avoid any possibility of syphilitic infection, it would be wise to carefully investigate the donors, although it is not very likely that the spirochaete will survive when the foreskins are preserved.

Our experience with the foreskins has suggested the possibility of successfully using bone and cartilage transplants obtained from stillborn infants of healthy parents, on the theory that such tissues are so rapidly growing as to afford a greater possibility of success.

NOTE.—This study was made at the suggestion of Dr. Russell S. Fowler, Surgeon in Chief of the Wyckoff Heights Hospital, Brooklyn, N. Y., and the work was done under his supervision at the hospital. The foreskins used were obtained from infants circumcised when they were seven to ten days old.

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NEUTRALIZATION OF HISTAMINE AND BURN TOXIN

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IN 1929, when the writer was associated with the Children's Surgical Division of the Cook County Hospital, he was impressed with the fact that in burns of moderate intensity in which healing was prolonged and especially when the inevitable superficial infection set in, there began the low grade fever, wasting, clammy skin and pallor usually associated with a low grade toxemia. Dressing and débriding these wounds daily, one could not divorce oneself from the idea that local absorption of some of the dead tissue must take place, and that it may account for at least some of the local edema and toxicity. Reasoning further, he rationalized that if the absorbed dead tissue acted as a toxin, then perhaps an antitoxin was produced. To this end blood was actually drawn from an old burn case who was awaiting skin grafts, but the opportunity to employ this serum did not present itself.

Later, while working in the Pathology Department of the same institution, postmortem observations in cases of burns revealed subcutaneous edema and internal dehydration, hyperemia and parenchymatous degeneration of the organs. In addition, and not infrequently, the occurrence of acute gastric ulcers presented themselves, from which bleeding had resulted in the exitus. At times the extent and severity of the burn was not marked.

As has already been reported (Rosenthal[11]), there is present in the blood of burned animals and humans a substance which causes contraction of the virgin guinea-pig uterus and is toxic to guinea-pigs. This substance was thought to be formed locally at the site of the burn, and only when present in large quantities could its presence be detected in the blood. A similar theory has been offered to explain anaphylactic shock (Dale and Laidlaw,[7] Biedl and Kraus,[4] Lewis and Grant,[8] Simonds and Brandes[12]). The following experiments were undertaken to determine if histamine and neutralizing substances were formed in burned animals and humans.

Method.—Blood was withdrawn periodically from the tail of second degree burned shoats and adult pigs under ether anesthesia, to determine the presence of neutralizing properties. The observations were made on the virgin guinea-pig uterus. To the serum, as well as to other fractions of the blood, 0.5 per cent phenol or chloroform (three drops to 20 cc.) was added immediately after withdrawal to prevent bacterial activity. All specimens were kept in an ice-box (2° C. to 4° C.) until used.

Similar observations were recorded for human blood, using serum from old burn cases where the lesions were healed or practically so.

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TABLE I

THE ACTION OF VARIOUS SERUMS ON HISTAMINE

Source	Type of Material	Time after Burn	Presence of Histaminoid Substances	Place and Time of Mixture			
				Room Temperature (30° C.–34° C.)	Incubation (37° C.)	Ice-Box (3° C.)	Combinations
Pig	Nor. S. (h)	—	0		++ (10 min.) 0 (3 hrs.)		
Pig	Nor. S.	—	0	++ (10 min.) ++ (30 min.) tr. (24 hrs.)	++ (10 min.) ++ (5¼ hrs.) + (6¼ hrs.) tr. (7 hrs.)	++++ (24 hrs.)	
Pig	Nor. cit. b. (h)	—	0		+++ (5 hrs.)		
Pig	Nor. cit. b.	—	0		+++ (5¼ hrs.)		
Pig	S.	2 mos.	+++		+++ (10 min.) +++ (25 min.)		
Pig	S. (h)	2 mos.	0 (h)		+++ (10 min.)		
Shoat	S.	20 da.	0		+++ (10 min.) + (6 hrs.)	+++ (24 hrs.)	(24 hrs. 3° C. + +++ 3 hrs. 30° C. + 20 min. 37° C.)
Shoat	S.	28 da.	0		tr. (5¾ hrs.)		
Pig	S.	2 mos.	0	++ (35 min.) ++ (50 min.) + (75 min.) 0 (24 hrs.)	tr. (5½ hrs.) + (6½ hrs.) + (6¾ hrs.)	tr. (24 hrs.)	
Human	S.	13 mos.	tr.		++ (10 min.) ++ (5 hrs.)		
Human	S.	22 da.	tr.		++ (10 min.) ++ (5 hrs.)		
Human	S.	25 da.	tr.				
Histamine	1 :100,000 dilution	—	++	++ (1 hr.) ++ (5 hrs.) ++ (24 hrs.)	++ (10 min.) ++ (4¾ hrs.)	++ (24 hrs.)	
Histamine (h)	1 :100,000 dilution	—	++		++ (10 min.)		
Ringer-Locke's	Phys. salt	—	0	++ (1 hr.) ++ (5 hrs.) ++ (24 hrs.)	++ (10 min.) ++ (3 hrs.) ++ (4¾ hrs.)	++ (24 hrs.)	(24 hrs. 3° C. + ++++ 2 hrs. 30° C. + 20 min. 37° C.)

++ = depression caused by 1 cc. of a 1 :100,000 dilution of histamine; S. = serum; nor. = normal; (h) = heated 60° C. for one-half hour; tr. = trace; cit. b. = citrated blood.

Results.—I. Counteracting Histamine.—Table I gives the results pertaining to the action of blood and serum upon histamine. All mixtures were made in equal proportions, using a 1:100,000 dilution of histamine in ½ to 1 cc. amounts. A two plus (++) reaction is to be interpreted as a contraction of the same degree as histamine. All other observations are recorded according to this standard. The solutions to be tested were all introduced into 35 cc. of Ringer-Locke solution in which the virgin ovary-uterus preparation was suspended (method described in previous publication[11]).

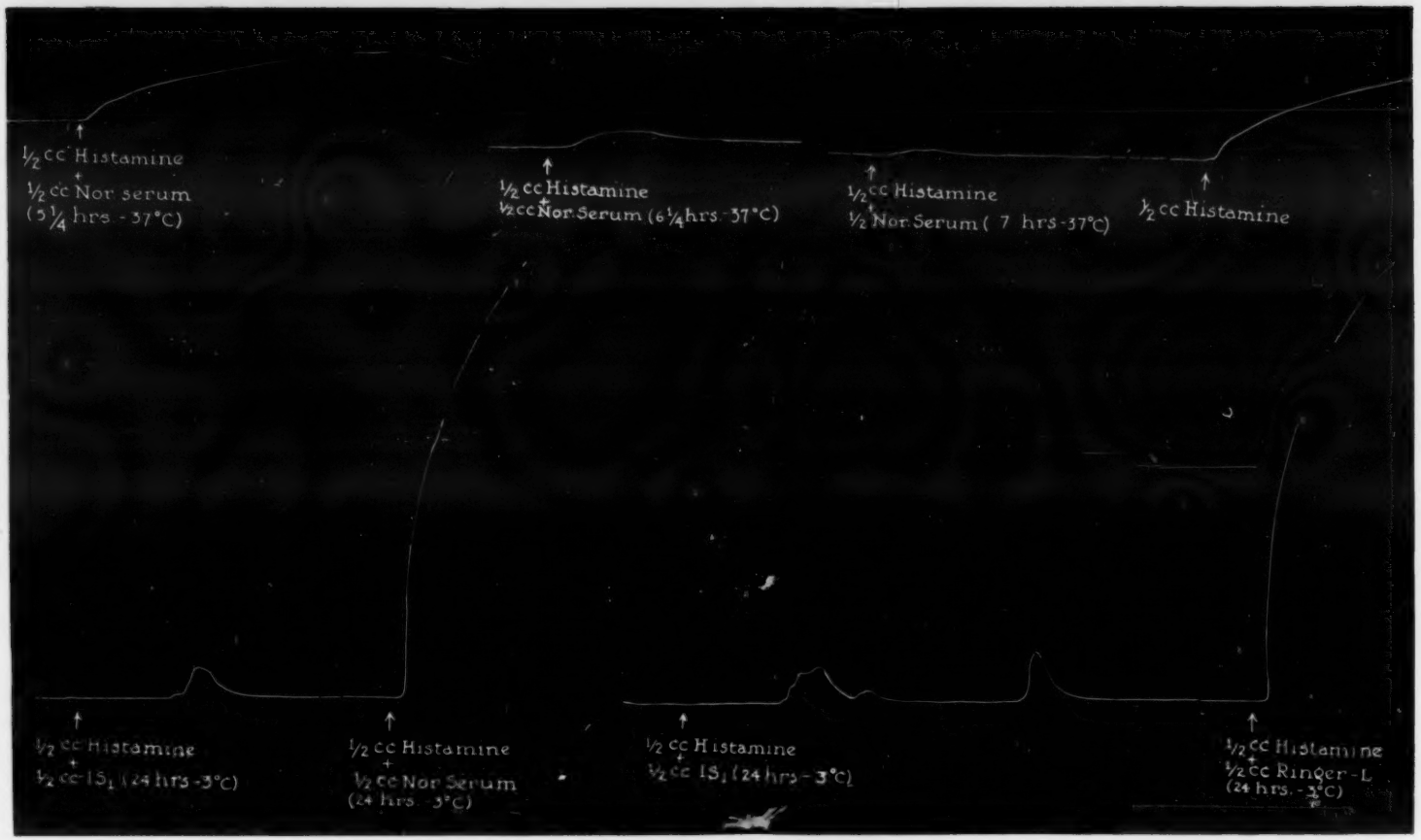
Normal Serum.—The mixing of histamine with normal pig serum did not decrease the action of the former unless kept overnight at room temperature (30° C. to 34° C.) or seven hours at 37° C. (Charts 1 and 2). At ice-box temperature (2° C. to 4° C.) contraction seemed to be enhanced (Chart 3). Heating the normal serum at 60° C. for half an hour did not destroy its neutralizing action. On the contrary, it was seemingly increased. Normal, citrated blood, heated or unheated, mixed with histamine for five to five and one-quarter hours (37° C.), or if incubated and then kept in an ice-box for 24 hours, did not neutralize the action of histamine as determined by the muscle strip. Serum under the same conditions was counteractive (Table I).

Burned Animals.—The serum of burned animals in which a histaminoid substance was still detected in moderate quantities failed to neutralize the action of histamine. Similarly, if the histaminoid action was destroyed by heating at 60° C. for half an hour, histamine neutralization was not demonstrable. Shortly after the burn, with the disappearence of the histaminoid substance, counteracting substances were still absent. Neutralizing bodies were contained in the serum of previously burned animals in whom the wounds had completely healed. If the latter serum was mixed with histamine for five and one-half hours at incubator temperature or kept in the ice-box or at room temperature overnight (Chart 3), the activity of histamine as determined by the muscle strip was diminished to absent (normal serum kept in the ice-box overnight failed to neutralize histamine (Chart 3).

Human serum thus far examined failed to neutralize histamine when applied to the smooth muscle strip.

Histamine itself in 1:100,000 dilutions, allowed to stand from one to 24 hours at room temperature, or incubated (37° C.) for from ten minutes to five and one-half hours, or at ice-box temperature (2° C. to 4° C.), or in any of the above combinations, did not show a decrease in its activity (Table I).

SUMMARY.—Normal pig serum has a limited ability to counteract or neutralize histamine in the dilutions used and under the conditions of the experiment. This action is possible only if the two substances are incubated for a long period of time. Serum of burned animals or humans in which histaminoid substances were still detectable failed to counteract histamine under the same conditions. The serum of recently burned animals



CHARTS 1, 2, 3.—The action of normal serum and the serum of burned pigs on histamine.

not containing histaminoid substances also failed to counteract the action of histamine, while in the older burned animals their serums had this neutralizing ability. This activity could be appreciated at incubator temperature (37° C.) or at ice-box temperature (2° C. to 4° C.). Heating at 60° C. for half an hour did not alter this activity.

II. Counteracting Burn Toxin.—Normal Serum.—The sources of the histaminoid substances are given in Table II. It appears that normal serum has a neutralizing action upon histaminoid substances only if the mixtures are incubated for a long period of time (Chart 4). Ice-box incubation is without effect. In one instance neutralization was not effective, but repeating it after two days gave positive results. Aging did not, as a rule, decrease the histaminoid activity, but it did enhance, in certain cases, the neutralizing ability of the serum. Contamination, as will also be noted later, impairs the neutralizing powers. The adult pig serum containing histaminoid substances was not neutralized by the normal adult pig serum. (Incubation only ten to 30 minutes.)

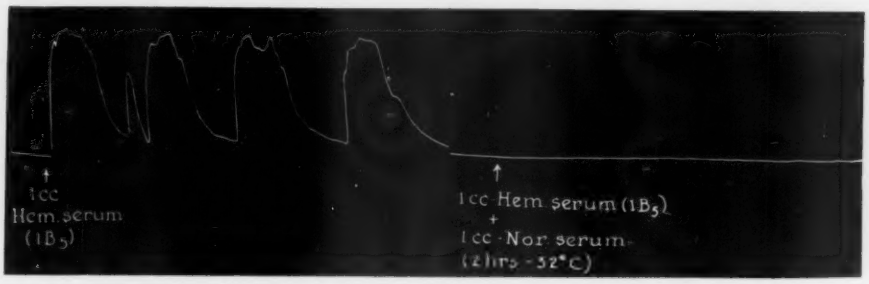


CHART 4.—The action of normal pig serum on burn toxin of shoat.

Human serum containing histaminoid substances was not counteracted by normal human serum under the conditions of the experiment (ten to 35 minutes at 37° C.).

Serum in Burned Cases.—Pigs.—The serum, red blood cells, or citrated blood of burned shoats containing histaminoid substances was not acted upon by the serum or citrated blood of adult pigs that had been burned previously but that still contained histaminoid substances. By destroying the latter activities by heating, neutralizing properties could not be demonstrated. The serum of adult burned pigs not containing histaminoid substances neutralized the action of the burn toxin of recently burned shoats and adult pigs (Chart 5). The serum of a shoat burned 20 days previously in whose serum no histaminoid substances could be detected counteracted burn toxin in adult pigs to the extent of 0.05 cc. of the former to 1 cc. of the latter (Charts 6 and 7). Normal adult pig serum under the same conditions (using the same uterus preparation) did not counteract the above in 1 cc. amounts. The above neutralizing serum when mixed with the serum of a recently burned shoat containing large quantities of histaminoid substances reduced the latter's action to one-half (Table III).

TABLE II

THE ACTION OF NORMAL PIG AND HUMAN SERUM ON HISTAMINOID SUBSTANCES

Source	Type of Material	Time after Burn	Presence of Histaminoid Substances	Source of Normal Serum	Presence of Histaminoid Substances	Reaction of Mixture on Virgin Guinea-Pig Uterus
Shoat	S.	19 hrs.	+++	Pig	0	+++ (48 hrs. 3° C.)
Shoat	Cit. b.	19 hrs.	tr.	Pig	0	0 (5 hrs. 37° C.)
Shoat	S.	4 da.	++++	Pig	0	++ (1¾ hrs. 37° C.)
Shoat	S.	5 da.	+++	Pig	0	0 (2 hrs. 37° C.)
Shoat	R.B.C.	5 da.	++	Pig	0	0 (3 hrs. 37° C.)
Shoat	Cit. b.	5 da.	tr.	Pig	0	0 (3 hrs. 37° C.)
Shoat	S.	9 da.	++	Pig	0	++ (2 hrs. 37° C.)
Shoat	S.	9 da.	++	Pig	0	tr.* (1 hr. 37° C.+ 1 hr. 32° C.)
Shoat	S.	14 da.	++	Pig	0	tr.
Pig	S.	2 mos.	+	Pig	0	+ (30 min. 37° C.)
Pig	S.	2 mos.	+	Pig	0	++
Human	S.	37 da.	+	Human	0	tr.
Human	S.		+	Human	0	+ (35 min. 37° C.)
Human	S.	34 da.	++	Human	0	++
Human	S.	27 da.	+	Human	0	+

* Repeated two days later.

++ = action of 1 cc. of a 1 :100,000 histamine solution; S. = serum; Cit. b. = citrated blood; R.B.C. = red blood corpuscles; tr. = trace; where not indicated, incubation (37° C.) five to ten minutes.

TABLE III

THE ACTION OF VARIOUS SERUMS ON THE BURN TOXIC

Source	Type of Material	Time after Burn	Presence of Histaminoid Substances	Source of Counteractant	Type of Material	Time after Burn	Presence of Histaminoid Substances	Reaction of Mixture on Virgin Guinea-Pig Uterus
								+++ (24–48 hrs. 3° C.)
Shoat	S.	19 hrs.	+++	Pig	S.	2 mos.*	+++	+++ (5 hrs. 37° C.)
Shoat	S.		+++					
	Cit. b.		tr.		S.			+++ (24–48 hrs. 3° C.)
	R.B.C.	5 da.	++	Pig	Cit. b.	2 mos.*	+++	+++ (5 hrs. 37° C.)
Shoat	R.B.C.	2 hrs.	+	Pig	S.	2 mos.	0	+
Shoat	S.	4 da.	++++	Pig	S.	2 mos.	0	+
Shoat	S.	9 da.	++	Pig	S. old cont.	2 mos.	0	++
Shoat	S.	9 da.	++	Pig	S.	2 mos.	0	tr. (1 hr. 37° C.)
Shoat	S.	14 da.	++	Pig	S.	2 mos.	++	
					(h)	2 mos.	0 (h)	+++
Pig	S.	2 mos.	+	Pig	S.	2 mos.	0	0 (30 min. 37° C.)
Pig	S.	2 mos.	+	Pig	S.	2 mos.	0	+
Pig	S.	2 mos.	+	Shoat	S.	20 da.	0	0
Pig	S.	2 mos.	+	Shoat	S.	20 da.	0	0
Pig	S.	2 mos.	+	Shoat	S. 0.3 cc.	20 da.	0	0
Pig	S.	2 mos.	+	Shoat	S. 0.05 cc.	20 da.	0	0
Shoat	S.	4 da.	++++	Shoat	S.	20 da.	0	++ (1 hr. 37°C.)
Human	S.	27 da.	++	Human	S.	13 mos.	tr.	0
Human	S.	34 da.	+++	Human	S.	13 mos.	tr.	tr.

* Biopsy sites not healed.

++ = action of 1 cc. of a 1 :100,000 histamine solution; S. = serum; Cit. b. = citrated blood; R.B.C. = red blood corpuscles; tr. = trace; cont. = contaminated; (h) = heated.

CHART 5.—The action of healed burned pig serum (IS_1) on burn toxin of sheat ($_3B_5$).

CHART 6.—The action of healed sheat serum ($_2B_6$) on burn toxin of pig (IS_1).

Human.—The serum of a burned human (13 months after extensive burning of the anterior surface of the body which had left numerous keloids and whose skin graft had become recently healed) neutralized human serum containing histaminoid substances (Chart 8). The tracings obtained with human specimens were strikingly similar to those obtained with the animal specimens (Chart 5). It is to be noted that under the same conditions, normal human serum had no effect.

CHART 7.—The action of healed shoat serum ($_2B_6$) on burn toxin of pigs (IS_4).

Contamination of the antihistaminoid containing serum nullified its neutralizing qualities. Aging, on the other hand, enhanced it. In rare instances, histaminoid substances became refractive to normal or burn toxin neutralizing serums.

SUMMARY.—Certain burned adult pig or shoat serums, in which detectable smooth muscle contracting substances have disappeared, have the ability to counteract the burn toxin of burned shoats or pigs, as determined by its activity on the virgin guinea-pig uterus. The same holds true for human serums.

CHART 8.—The action of healed burned human (H_3) on burn toxin of human (H_5).

Normal serum of either man or animal has definite histaminoid neutralizing properties but only if incubated (37° C.) over a long period of time.

Discussion.—In a previous publication,[11] the author has demonstrated that the serum of burned animals and humans contained histaminoid substances. The present work seems to indicate that the serum in cases of healed burns (humans or animals) contains neutralizing substances for both humans and animals, respectively, as determined by the action of the mixture on the virgin guinea-pig uterus. Normal serum, too, possesses this property to a limited extent. (The failure of Busson and Kirschbaum[5] to neutralize histaminoid substances by shaking with normal serum may be accounted for by the fact that they did not incubate the mixtures at 37° C.)

In anaphylaxis, as in allergic states (bacterial, food, pollens, *etc.*), where antigen and antibodies are supposedly involved, histaminoid substances, according to the latest theories, play an active rôle (Aronson,[1] Lewis and Grant,[8] McConnell[9]). Thus, the histamine wheal in allergic states simulates the allergin wheals (Lewis and Grant[8] and McConnell[9]), and in acute anaphylaxis histaminoid substances are markedly increased in the lung (Feldberg and Schilf).

The existence of neutralizing properties against histamine in the body has been denied by Feldberg and Schilf, who believe, rather, that the liver and the lung remove the histamine from circulation. Adrenalin will reduce the histamine skin wheal, and if injected at the same time no wheal will develop (Mogena and Fernandez[10]). The blood pressure fall in histamine shock can be elevated to normal by adrenalin (Chen[6]). Barium chloride will also do the same, but the plasma exudation and the increase of hemoglobin concentration is not affected (Underhill and Ringer[13]). Best and McHenry[3] have suggested the presence of an histaminase, for in the autolysis of tissues, histamine disappears, but if the autolysate is heated at 95° C. for four minutes, the histamine persists.

Histamine-like substances found in burns are not influenced by adrenalin, hypophyseal extract or grapesugar solution, according to Feldberg and Schilf.

SUMMARY.—Under the conditions of the experiment: (1) There are indications that the serum of healed burned shoats, pigs and humans contained substances which will neutralize histamine and burn toxin, as determined by the action of the mixture on the virgin guinea-pig uterus. This reaction takes place at room (30° C. to 34° C.), ice-box (2° C. to 4° C.), and incubator temperatures (37° C.). Heating at 60° C. for half an hour does not destroy this action. (2) Normal serum also neutralizes histamine and burn toxin to a limited extent, and then only at incubator temperature (37° C.) for a period of time.

I wish to thank Drs. Bernard Fantus and Lloyd Arnold for their interest in this work.

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FRACTURES OF THE PELVIS

A REVIEW OF FOUR HUNDRED FORTY-NINE CASES

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THE frequency with which fractures of the pelvis were encountered in the Delaware County Hospital stimulated an interest in this supposedly unusual occurrence, and has prompted the report of the series of cases herewith submitted.

In reviewing a series of 449 cases of fractures of the pelvis, collected from the Pennsylvania, Jefferson, and Presbyterian Hospitals in Philadelphia and from the Delaware County Hospital in Drexel Hill, several interesting facts were noted. While previously their occurrence has been regarded as relatively infrequent, various writers lately consider such injuries to be rapidly increasing and that, in fact, they have become fairly common. The reason for this increase is attributed to the more general use of the automobile, bus, and truck, and the lack of respect on the part of the public for traffic laws and regulations. Both of these facts; namely, the increase in the number of such injuries, and that the increase is due to the automobile or motor vehicle, are substantiated by this study.

Of the 449 cases reviewed in this study, 103 are from the Jefferson Hospital (1910–1934), 146 from the Pennsylvania Hospital (1907–1934), 61 from the Delaware County Hospital (1927–1934), and 139 from the Presbyterian Hospital (1920–1934), all years inclusive. The average number of cases at the Jefferson Hospital from 1910 to 1924, a period of 15 years, was 3.6 per year, from 1924 to 1934, 4.8 per year, and from 1930 to 1934, an average of 8.2 per year. At the Pennsylvania Hospital the average number from 1907 to 1924 was 4.6 per year, from 1924 to 1934, 6.3 per year, and from 1930 to 1934, eight per year. At the Presbyterian Hospital the average from 1920 to 1934 was 6.6 per year, 1920 to 1930, 8.6 per year, and 1930 to 1934, 10.6 per year. At the Delaware County Hospital the average from 1927 to 1930 was 6.2 per year and from 1930 to 1934 was nine per year. This shows the rapid increase in the frequency of such fractures (Table I).

The ages of the patients varied from one year of age to 80, with three ages being exempt; namely ages three, 53, and 68; and Presbyterian Hospital had two cases over 80 years of age. The greatest number of patients was between 17 and 40 years of age with the largest number at age 27.

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TABLE I

INCIDENCE OF FRACTURES OF THE PELVIS AT VARIOUS HOSPITALS BY YEARS

Year	Jefferson	Pennsylvania	Delaware Co.	Presbyterian
1907		3		
1908		3		
1909		3		
1910	1	3		
1911	2	6		
1912	6	1		
1913	3	14		
1914	3	5		
1915	4	6		
1916	2	6		
1917	2	5		
1918	1	4		
1919	6	3		
1920	6	4		4
1921	6			5
1922	5	9		5
1923	6	4		8
1924	2	4		11
1925	6	10		8
1926	1	4		11
1927		5	4	9
1928	1	1	8	12
1929	7	3	10	13
1930		9	3	15
1931	13	5	14	13
1932	5	8	10	8
1933	9	8	6	2
1934	6	10	6	15
Total	103	146	61	139

At all the hospitals there were more males than females, with a general average of 62.2 per cent males and 37.8 per cent females. Also there were more white than colored patients at all four hospitals, with a general average of 88.4 per cent white to 11.6 per cent colored. 69.4 per cent were married and 30.6 per cent single. There were 22 races represented in this series, with 65 per cent being Americans. There were 32 types of occupation represented by these patients, with a large number classified as miscellaneous, and a larger number that were never classified at all. Housewives rank first, school children second and laborers third.

The automobile was responsible for 36 per cent of the cases in which the cause was listed, and industrial accidents for 33 per cent. Eight per cent of the industrial accidents were also due to the automobile. Of the automobile cases the most frequent cause was a pedestrian hit by automobile, collision of two cars second, and collision of car with some stationary object third. Falls from various heights were responsible for most of the industrial cases (Table II).

TABLE II

CAUSES OF FRACTURES OF THE PELVIS

	Jefferson	Pennsylvania	Delaware Co.	Presbyterian
Automobile	16	30	40	63
Collision 2 cars	3	7	18	25
Collision car and trolley	1		3	3
Pedestrian hit by automobile	8	22	14	29
Collision of car and object	2	1	5	6
Collision of automobile and train	1			
Industrial	36	46	17	38
Falls	20	17	8	19
Horse kicks	1			2
Trains	1			9
Wagon	2		1	
Elevator	3	3		
Automobile accident	2	2	5	2
Wagon	1			
Miscellaneous	20	64	5	38

In a few of the cases the exact direction of the force causing the fracture was ascertained. The majority of the records made no mention of this fact. Out of 103 cases, 71 or 69 per cent resulted from the force being applied laterally and in 26 cases or 25 per cent the direction of the force was anteroposterior.

Pain as is expected was the predominating symptom. One would expect pain in 100 per cent of the cases for it is hard to conceive of an injury severe enough to cause a fracture of the pelvis without some pain resulting, yet it was only listed on the records as a symptom in 345 of the 449 cases. Tenderness which was present in 278 cases came second in frequency, and again the same thing can be said about this symptom or sign as for pain. It should be recorded in 100 per cent of the cases. Difficulty in walking ranked third, abdominal tenderness fourth, and one of the old cardinal signs—crepitus—came fifth. Shock was recorded as being present in only 75 cases. Another point which shows the incompleteness of hospital records is the lack of certain laboratory work. Uranalyses were made on only 226 of the 449 cases. 143 were negative for blood and 83 or 37 per cent were positive. Wassermann examinations were made on 74 cases with 11 positive and 63 negative reports (Table III).

Of those cases actually roentgenographed, the report recorded 38.7 per cent were single, 44 per cent multiple, 14.7 per cent comminuted, and 2.6 per cent were compound fractures. There were many other associated fractures, the most frequent being the tibia; radius was second, and femur third. There were 11 cases with fractures of the vertebrae. In all there were associated fractures of 18 different bones (Table IV).

TABLE III

RÉSUMÉ OF SYMPTOMS IN FRACTURES OF THE PELVIS

	Jefferson	Pennsylvania	Delaware Co.	Presbyterian
Pain	68	98	62	117
Tenderness	56	67	58	97
Crepitus	15	23	4	6
Ecchymosis	4	13	4	8
Difficulty in walking	40	33	28	48
Leg shortening	3	4	1	2
Shock	17	27	9	22
Abdominal tenderness or rigidity	19	20	15	5
Miscellaneous	10	1	3	25
Unconsciousness				
Bleeding from urethra				
Bleeding from vagina				
Bleeding from rectum				
Concussion				
Headache				
Wassermann				
Negative	11	42		10
Positive	4	6		1
Blood in urine				
Negative	41	71	31	
Positive	14	20	26	23

TABLE IV

TYPES OF FRACTURES OF THE PELVIS

	Jefferson	Pennsylvania	Delaware Co.	Presbyterian
Single	24	52	25	7
Multiple	42	29	27	25
Comminuted	6	15	6	14
Compound	4		1	2

INCIDENCE OF ASSOCIATED FRACTURES

Femur	3	5	2	10
Tibia	3	5	4	13
Fibula	2	3	3	6
Humerus	1	1	1	3
Ulna	1	2	2	7
Clavicle	1	3	1	5
Ribs	2	3	3	5
Vertebrae	1	3	2	5
Skull		3		12
Mandible	1	1		1
Tarsal	2	1	1	
Radius	6	4	3	10
Olecranon	1			2
Patella		1		
Metatarsal		2		
Carpal		1	2	
Scapula				1
Os calcis		1		
Astragalus		1		

In this series the left pubic bone was the one most frequently fractured (163 of the 449 cases), and the superior ramus was fractured more frequently than the inferior ramus. The right pubic bone, fractured in 149 of the cases, was second in frequency and again the superior ramus was more frequently involved than the inferior ramus. This gives a combined total for fractures of the pubic bone of 312 or 69 per cent. The right ilium was fractured in 95 cases, left 89, right ischium 70, left ischium 72. The left acetabulum was fractured 41 times and the right 32 times, a total of 73. Of this number there were 15 cases of intrapelvic protrusion of the acetabulum, and in eight cases the head of the femur protruded into the pelvis. I do not feel that this represents the true number of cases since the roentgenologic reports of the early cases made no mention of such a condition. However, it is still in keeping with some other statistics. Noland and Conwell,[7] in a study of 125 cases, found the acetabulum fractured in 17.6 per cent of the cases and in this series it occurred in 16.3 per cent. Wakeley,[8] in a study of 100 cases, reported only two instances of acetabular fracture, while Boorstein,[1] in reporting 100 cases, found the acetabulum fractured in 11 per cent of the cases. The other bones were not fractured so frequently (Table V).

TABLE V

PELVIC BONES INVOLVED IN FRACTURES OF THE PELVIS

	Jefferson	Pennsylvania	Delaware Co.	Presbyterian
Left pubic	26	44	33	60
Superior ramus	16	31	22	33
Inferior ramus	11	14	18	40
Right pubic	23	47	22	57
Superior ramus	19	30	15	29
Inferior ramus	12	13	12	42
Left ischium	14	23	10	25
Superior ramus	5	11	4	17
Inferior ramus	7	1	6	9
Right ischium	14	16	5	35
Superior ramus	6	6	1	27
Inferior ramus	3	3	4	14
Left ilium	13	46	8	22
Right ilium	19	44	9	23
Sacrum	4	14	4	15
Coccyx	26	22		10
Left acetabulum	12	16	3	10
Right acetabulum	3	17		12

Of the pubic bone fractures one encountered a fracture of a single ramus more often than where two or more rami were involved. Next in frequency were two rami on the same side, then two rami, one on each side, four rami, and then three rami. Of the ischium a single ramus was first, two rami, one on each side, second, and two rami on the same side, third. There was an upward displacement of one-half of the os innominatum

in ten cases, or only 2.2 per cent. While this is not as high a percentage as some authors give, it is as high and even higher than others and many writers have made no mention whatsoever of such a finding. Again, there may be some discrepancy in this percentage due to the incomplete roentgenologic report of the early cases. Most of the roentgenologic reports made no mention of the overriding of the fragments where both rami on one side were involved, with a possible resulting contracted pelvis. From our follow up results, this did not prove to be as important a factor as it would be thought to have been. There were 68 cases where two or more rami were fractured or 15 per cent of the cases.

There were 13 different forms of treatments listed. Rest in bed, either with or without sand bags, ranked first and some form of a pelvic sling or binder with some extension being second. My own opinion, which is also advocated by many men such as Conway,[2] and Noland and Conwell,[7] is that one should use that form of treatment best suited to each individual case and in a majority of cases it would consist of extension on the lower extremities with some form of pelvic sling. The one described by Noland and Conwell[7] seems to me to be the best combined form of hammock and extension. It is a very interesting and important observation to notice the immediate, as well as the amount of, relief the patient received when extension and hammock were applied. I do not think it of interest or necessary to go into detail concerning everything in the form of treatment employed on these cases from the time of admission to the time of discharge. I am interested only in that form of treatment directed to the fracture itself. However, I think it is noteworthy that there were only seven cases operated upon: two for internal injury and hemorrhage, one for ruptured bladder, and four for ruptured urethra. A supplementary form of treatment is discussed later which will be found to be of decided benefit in shortening the period of hospitalization and in hastening the return of normal function.

There were 46 different kinds of complications listed in this series. There were only six cases of ruptured urethra and only four cases of ruptured bladder. This is a very small percentage when compared with the statistics reported by others. Conway reviewed 56 cases with only four instances of genito-urinary injury. This gives a percentage of a little over seven, while in this series the percentage is a little over three for all genito-urinary injury. Gilmour in his series of 81 cases reports nine cases of rupture of the bladder as compared with four in this series of 449. Culp and Findlay,[3] in a series of 35 consecutive cases, had three instances of ruptured bladder and two with rupture of the urethra. Visceral injury other than that of the genito-urinary tract was very rare. There was one case of rupture of the rectum, and two cases of intraperitoneal hemorrhage. Wakeley,[8] in a series of 100 cases, found visceral complications in 11 cases. While a great number of the cases that die within the first few hours after admission must have some form of serious visceral injury, it is extremely rare in those that live and survive the first few hours. It is, therefore, very

striking, in such a large group of cases collected from four hospitals, to discover the relative infrequency with which complications of the genito-urinary tract were encountered.

There were 144 cases discharged as cured, 249 improved, four unchanged, 11 signed releases, and there were 41 deaths. Of the deaths 20 or about one-half occurred during the first 24 hours and an additional 11 occurred during the first week (Table VI).

TABLE VI

CONDITION ON DISCHARGE OF PATIENTS FOLLOWING FRACTURES OF THE PELVIS

	Jefferson	Pennsylvania	Delaware Co.	Presbyterian
Improved	32	52	20	5
Improved (not walking)	1			1
Improved (on crutches)	7	19	8	19
Improved (walking)	20	14	21	30
Signed release	3	1	4	3
Cured	31	39	5	69
Unchanged	3	1		
Deaths 1st 24 hrs.	4	9	1	6
Deaths 1st week after 24 hrs.	2	4	2	3
Deaths after 1st week		5	1	4

There were 13 different actual causes of death where the cause was determined. Pneumonia six, shock five, pulmonary edema four, ruptured bladder two, *etc.* Again, it is of more than passing interest to note that only two deaths out of 41 resulted from injury to the genito-urinary system. This is in keeping with the findings from the study of the complications when it was found that only 3 per cent of the cases had severe genito-urinary complications (Table VII).

TABLE VII

CAUSES OF DEATH IN FRACTURES OF THE PELVIS

	Jefferson	Pennsylvania	Delaware Co.	Presbyterian
Pulmonary edema		2		2
Ruptured bladder		2		
Hemorrhage		1		
Pneumonia		2	1	3
Erysipelas				1
Carcinoma of sigmoid				1
Heart attack				1
Shock	4		1	
Paralytic ileus			1	
Pulmonary embolus	1			
Internal injuries	3			
Peritonitis	1			
Internal hemorrhage		1		

It is of particular interest, not only from the economic standpoint but also from that of the period of suffering on the part of the patient, to

study the number of days of hospitalization. The shortest stay for any case was one day, the longest 240. There were one or more cases for every period of time from one day to 63 consecutively, and 14 different periods from 63 to 100, and seven different for over 100 (Table VIII).

TABLE VIII

STATISTICS RELATIVE TO TIME OF HOSPITALIZATION IN FRACTURES OF THE PELVIS

Days	Jeff.	Penn.	Del. Co.	Presby.	Days	Jeff.	Penn.	Del. Co.	Presby.
1	4	11	2	10	43	1	2		1
2	1	2	1	1	44		2	2	4
3	1	2	3	1	45				6
4	2	2	6	3	46	2	1	1	1
5	2	1	1	1	47	1	2	1	
6		2		4	48				4
7	1	3	2	2	49	2	4		4
8	1	3	1	1	50	1	2	1	5
9		3	1		51	1		2	2
10	1			1	52	1	1	1	4
11	1	3	2	2	53		1		2
12	3	1			54	1	3		2
13	3	2		4	55	1	2	1	1
14		2	1	3	56		1		1
15	3	1	1	2	57		1	1	2
16		1			58			1	
17	3	5	1	4	59		4		1
18				3	60			1	2
19	2	4	1	3	61	1	1	2	1
20	3	1		1	62		1		1
21		4	1	2	63	1	1	1	
22		2			66				1
23	2	3	2	1	68				4
24		1		3	69		1		
25		2	1	3	70	1		1	
26		2		1	73	1	1		
27			2		76	1			
28	2	4		2	77				1
29		2	2	2	79	1	1		
30	4		1	1	82		1		1
31	1	4	1	4	84		1		
32	3	3		3	85		1		
33		3	3	1	88		1		
34		3	2	1	97				1
35	3	4	1	2	100		1		
36		2	1	1	115		1	1	
37		1		1	118	1			
38	2				126		1		
39	4	3	2	4	141	1			
40		5	1	4	231				1
41	1	4	2	1	240	1			
42	1	3	1	2					

The average number of days, therefore, that the patient was in the hospital is as follows: Jefferson Hospital 34, Pennsylvania 34, Presbyterian

35, Delaware County 29, an average of 33 days. The average number of days the patient spent in the hospital not including those patients who were in the hospital only three days or less, that is, those cases that died, signed releases, or were moved to another institution within the first three days after injury, was: Jefferson Hospital 37, Pennsylvania Hospital 37, Presbyterian Hospital 38, Delaware County Hospital 32, an average of 36 days (Table IX).

TABLE IX

AVERAGE NUMBER OF DAYS OF HOSPITALIZATION AFTER FRACTURES OF THE PELVIS

	Jeff.	Penn.	Del. Co.	Presby.	Total
Average number days in hospital	34	34	29	35	33
Average number days in hospital, not including patients in hospital only three days	37	37	32	38	36
Average number days in hospital, not including fractures of coccyx	41	39	32	40	38

Also the average number of days spent in the hospital by a patient, not including those cases with fracture of the coccyx was: Jefferson 41, Pennsylvania 39, Presbyterian 40, Delaware County 32, an average of 38 days.

One will note that the average for Jefferson, Pennsylvania, and Presbyterian Hospitals run along about the same, but that of the Delaware County Hospital was a little less, being four to six days below the average. This shortening of the hospital stay is not due to less severe injuries but, we feel, to a supplementary form of treatment. When a case has been admitted and the form of treatment decided upon, the Physical Therapy Department is called in and their form of treatment started immediately. The follow up records show the chief complaints and disabling factors were pain and stiffness in the legs and back. As in fractures in other parts of the body, there are swelling, blood extravasation, and injury to the soft tissues. No one will deny the value of luminous heat, infrared treatment, faradic or sinusoidal current, medical diathermy, Scotch douche, underwater exercises, massage and physiotherapeutic exercise in the relief of pain, the eradication of swelling, and the restoration of normal function following fractures in other parts of the body. It is the opinion of many physical therapists that the formation of scar tissue around nerves and tendons, in muscles and in soft parts, following fractures of other bones, can be definitely decreased by early and continued use of various forms of physiotherapy treatment. Those measures, therefore, as far as possible should be employed in the treatment of fractures of the pelvis.

Fractures of the pelvis are one of our serious, long drawn out, and disabling forms of injury. Disabling because of the injury to the legs, back and pelvis, because of extension to legs, and because of continued pressure on back from being bedfast. Our records at the Delaware County Hospital show, therefore, that by starting physical therapy treatment at the beginning we not only shortened their hospital stay, and their total period of dis-

ability, but made this period more comfortable for them. This then becomes an economic problem, for it means a saving to the patient, the hospital, the industrial and liability insurance companies, and to the employer.

Another point of interest, and one that has unquestionably influenced surgeons in keeping patients in the hospital for a longer period of time, was the reports of the roentgenologists on the secondary roentgenologic examination. It was the invariable rule in all four hospitals to obtain a report of the roentgenologic examination made a short time before discharge particularly relevant to the determination of callous formation, stating there was not sufficient callous to allow of weight bearing. This, therefore, has made the stay in all four hospitals a little longer than was necessary. In getting the patients out of bed, walking, and in discharging them from the hospital, one should be influenced more by the clinical findings than by the roentgenologic report.

Follow Up Results.—Out of 163 cases we attempted to follow, 72 or 43.6 per cent either replied to a questionnaire, visited the Follow Up Clinic or we interviewed them at their homes, with the following results:

(1) Of the 72 actually followed, 48 or 66.67 per cent stated they were entirely cured from their accident. Of the 24 cases who stated they were not cured, 15 or 62.5 per cent were either on compensation or their suit for damages had not been settled.

(2) Of the 24 cases not cured, 18 or 75 per cent complained of pain either in hip, back, leg, or knee. All 24 or 100 per cent complained of pain on walking. Seventeen of the 24 or 70.8 per cent complained of stiffness in hip joint, 12 of 24 or 50 per cent complained of stiffness of back and ten of 24 or 41.7 per cent complained of stiffness in one or both knee joints.

(3) Twenty-four or 33.33 per cent stated that at sometime or other they had had some neuritis in the right leg and 25 or 34.7 per cent had neuritis in the left leg. This is in keeping with the findings of the bones fractured, since the left pubic was fractured 163 times to the right 149, and the left ischium 72 to the right 70. Fifty-nine or 42.4 per cent complained of neuritis in the back.

(4) Nine or 12.5 per cent complained of some difficulty with their bowels, and ten or 13.9 per cent complained of some difficulty on urination.

(5) Seven or 9.7 per cent had some shortening in the right leg and ten or 14 per cent had some shortening in the left leg. Again this is in keeping with the findings of the bone fractured since the left side was fractured more frequently than the right.

(6) Contracted pelvis was not a disabling factor and three cases in the female sex have since gone through pregnancy with normal spontaneous delivery.

(7) The average period of time from the date of injury to the time the patient stated he or she was able to do any kind of work was 21 weeks. Leaving out those cases where complications played a part, the average was 16.4 weeks. The average period of time from injury to the date the patient

was able to resume his regular work was 28.3 weeks. Again leaving out those cases where complications were a contributing factor the average was 23.6 weeks.

Since physical therapy treatment has shortened the hospital stay four to six days, then continued physical therapy treatment should shorten the total period of disability from seven to 21 days or even more. With these four hospitals averaging for the past six years a total of 33 cases per year, one can appreciate what a great saving it will be in every way and to everyone concerned.

SUMMARY AND CONCLUSIONS

(1) Fractures of the pelvis, because of the automobile, are increasing in frequency.

(2) Multiple fractures of the pelvis occurred more often than single fracture.

(3) Extension to the legs with overhead suspended hammock and spreader is the treatment of choice.

(4) Genito-urinary injury and complications are rare.

(5) Death rate is very low—40 out of 449 cases.

(6) Sixty-six and two-thirds per cent stated they were cured six months or more after their injury.

(7) The chief disabling symptom was pain either in legs or back.

(8) Nine point seven per cent had some permanent shortening of right leg, 14 per cent of the left leg. With extension this percentage can be lowered.

(9) The average period of total disability for uncomplicated cases was 16.4 weeks.

(10) The average period of uncomplicated cases before resumption of regular work was 23.6 weeks.

(11) Physical findings are more important than the reports of the roentgenologists, in determining when one can begin to get the patients out of bed, walking, or discharging them from the hospital.

(12) Physical therapy is a very valuable adjunct in the treatment of pelvic fractures and should be started immediately.

(13) When this is done, the period of hospitalization and total disability is shortened.

I wish to thank the various surgeons of these four hospitals for the privilege of incorporating their cases in this series.

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DISCUSSION.—DR. EDWARD HODGE (Philadelphia).—I would like to commend Doctor Rankin for his paper and his presentation. It is very rarely that a paper of this type is composed so interestingly. It is bound to be statistical. I believe this is the largest series of cases reported in this country. There is only one larger series collected in the world so that this is a vast amount of material well presented. One salient feature which we want to grasp is the treatment, particularly the suspension with traction, which I have not heretofore sufficiently employed, I am frank to admit. The other is the early employment of physiotherapy; this reduces pain and the patient's stay in the hospital, and in these days of insurance we are bound to take more cognizance of this than formerly. One factor of interest to me is that Doctor Rankin is one of my associates at the Presbyterian Hospital and is interested in this work, and further, the first pelvic sling was devised by Dr. Douglas Murphy of this city while an intern at the Presbyterian Hospital.

DR. LYNN M. RANKIN in closing stated that with extension the legs are kept immobilized and unless you give them some motion you get stiffness of the ankle, knee, and hip joint. This is minimized by active and passive motion, massage, and the patients are given some form of heat which helps to relieve the pain and discomfort. This heat is applied in the form of infrared light and by use of the medical diathermy to the back. The main thing is to give massage and motion to the legs and back. The patient is usually disabled from long disuse of the leg. Physiotherapy in these forms is started as soon as possible, after the patient has had extension applied and the hammock sling adjusted, usually within a few days after admission.

THE SHELVING OPERATION AS AN ADJUNCT TO OPEN REDUCTION IN CONGENITAL DISLOCATED HIP AND ITS USE IN PARALYTIC AND PATHOLOGIC DISLOCATIONS

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(Continued from page 110)

PART II

THE palliative treatment of congenital dislocation of the hip, as carried out in this clinic, was recently studied. In the majority of the treated cases the shelving operation had been used. In these, attention was called to the fact that no good results were obtained in patients operated upon before the tenth year. The question now arises whether the failure was due to choice of the wrong procedure or whether the fault lay in the execution of the operation. That is to say—is the shelving operation doomed to failure if performed on the younger subject? In an attempt to determine this point, all shelving operations performed here, exclusive of those studied in the previous report, have been reviewed and form the basis of the present investigation (Table I).

TABLE I

14 patients with congenital dislocation	
5 patients with paralytic dislocation	
6 patients with pathologic dislocation	
1 patient with traumatic dislocation	
Total 26 patients	

Six of the cases with congenital dislocation had bilateral luxation, but in only one of these was the shelf operation performed on both sides. Thus we have 26 patients presenting 32 dislocated hips, of which 27 hips were shelved. In two of the bilateral cases which were shelved on only one side a second shelving was effected because of absorption of the first shelf. Thus we have a total of 29 shelf operations to study.

One of the cases of unilateral luxation (M.H.) was complicated by poliomyelitis affecting the dislocated extremity. This case was mentioned in our earlier report and was discarded. It is included here purely for the sake of completeness. As stated, one of the bilateral cases was shelved on both sides. This case is complicated by Little's disease. In the case complicated by poliomyelitis the hip was not reduced at the shelving. In the other patient over ten the acetabulum was reamed out at the time of the shelving. All other cases had the open reduction in conjunction with the shelving. The ultimate

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fate of these hips and the roentgenologic appearance of the shelf itself are given in Table III.

TABLE II

SHELVING WITH OPEN REDUCTION THE CONGENITALLY DISLOCATED HIP

Age and Type Incidence

Age at Time of Operation (in Yrs.)	Total No. of Patients	Unilateral	Bilateral
1– 5	5	3	2
6–10	7	3	4
10 and above	2	2	
Totals	14	8	6

TABLE III

ANATOMIC END-RESULTS OF SHELVING COMBINED WITH OPEN REDUCTION

Unilateral

Patient	Age at Time of Oper. (in yrs.)	Anat. End-result	Time Post-oper.	Roentgenographic Appearance
C. L.	2	Fair	1½ yrs.	Hip is subluxated; shelf of good density. Head abuts against shelf but is incompletely covered by it
N. K.	4½	Poor	3 yrs., 9 mos.	Small shelf of good density but too high. Is 1½ in. above head. Hip is subluxated. Anteversion is marked
L. N.	5	Poor	1¼ yrs.	Shelf almost completely absorbed. Is high. Hip is still reduced
J. R.	6	Poor	1 yr.	Hip is redislocated. Head abuts a small spicule of bone representing remainder of shelf, most of which lies anterior to head. Shelf was placed high
R. A.	6	Fair	3½ yrs.	Shelf is of good density. Covers only ½ of head but is closely applied to it. Hip is subluxated
L. E.	6	Poor	1 yr., 9 mos.	Hip is dislocated. Shelf almost entirely absorbed
P. O.	11	Good	3¼ yrs.	Massive shelf. Covers head completely. Hip reduced
M. H.*	16	Fair	2 yrs.	Shelf covers ½ head. Good density. Hip remains dislocated *since it was never reduced at operation*

* This case is complicated by poliomyelitis. It represents an instance of shelving without reduction. It is included here simply for completeness.

Thus we see that in the unilateral cases there is only one good result and three fair results after one year of observation. The good result was obtained in the patient 11 years old at time of operation.

In the bilateral group only one good result is found after an observation period of one year.

TABLE IV

ANATOMIC END-RESULTS OF SHELVING COMBINED WITH OPEN REDUCTION

Bilateral

ONE SIDE SHELVED

No.	Patient	Age at Time of Oper.	Anat. End-result	Time Post-oper.	Roentgenographic Appearance
1	H. M.	4½ yrs.	Poor	1½ yrs.	Hip redislocated. Slight bony spicule at site of shelf. Inlay portion of shelf only remains
2	H. M.*	5 yrs., 9 mos.	Good	1 mo.	Good shelf. Is massive. Lies ¾ in. above head. Covers head completely. Hip is reduced
3	D. E.	5 yrs.	Poor	2 yrs.	Shelf is completely absorbed. Hip is subluxated
4	D. E.†	7 yrs.	Good	3 mos.	Massive shelf ¾ in. above head. Covers head completely. Hip is reduced
5	A. R.	6 yrs.	Poor	1 yr.	Shelf far above head. Too high to be of value. Hip is subluxated
6	F. C.	7 yrs.	Poor	2 yrs., 7 mos.	Shelf completely absorbed. Hip is subluxated
7	M. S.	8 yrs.	Poor	5½ mos.	Massive shelf but too high. Hip is subluxated
				BOTH SIDES SHELVED	
8	R. T.	8 yrs.	Good	1 yr., 10 mos.	Shelf is of good density. Is close to head and covers it completely. Hip is reduced
9	R. T.	8 yrs.	Poor	1 yr., 9 mos.	Shelf is completely absorbed. Hip is still reduced

* Same as Case No. 1.
† Same as Case No. 3.

All films in this and the unilateral group were examined stereoscopically.

TABLE V

INITIAL ANATOMIC RESULTS IN CASES OF SHELVING COMBINED WITH OPEN REDUCTION

Unilateral

Patient	Age at Time of Oper. (in yrs.)	Immed. Anat. Result	Roentgenographic Appearance
C. L.	2	Good	Shelf covers head completely. Head is against shelf. Hip is reduced
N. K.	4½	Poor	Shelf is 2 in. above head. Is long and of ample size to cover head completely
L. N.	5	Fair	Shelf is 1 in. above head. Is of ample size and covers head completely. Hip is reduced
J. R.	6	Poor	Shelf lies 1 in. above rim of primary acetabulum. It is high above head. It is large enough to cover head, however
R. A.	6	Good	Hip reduced. Massive shelf close to head. Covers head completely
L. E.	6	Poor	Hip not reduced at operation as operator believed. Shelf is small and does not cover head
P. O.	11	Good	Hip is reduced. Shelf is massive and covers head completely
M. H.*	16	Fair	"X-ray shows good alignment and position"

* This case is complicated by poliomyelitis. The postoperative film is not now available. The report is that of the roentgenologist. *All films except that on M. H. were examined stereoscopically.*

The analysis, however, is far from complete. Before any operation may be condemned on the basis of end-results, as having failed to achieve the desired objective, it is essential that we ascertain whether or not the operation was correctly performed in the first place. In other words, in case of failure, is the operation or is the operator culpable? The immediate anatomic results in our cases, as seen in the roentgenogram taken a few days after operation, are given in Tables V and VI.

TABLE VI

INITIAL ANATOMIC RESULTS IN CASES OF SHELVING COMBINED WITH OPEN REDUCTION

Bilateral

No.	Patient	Age at Time of Oper.	Immed. Anat. Result	Roentgenographic Appearance
			ONE SIDE ONLY SHELVED	
1	H. M.	4½ yrs.	Poor	Shelf is too high. Is 1½ in. above head. Hip is reduced
2	H. M.*	5 yrs., 9 mos.	Good	Massive shelf ¾ in. above head. Hip is reduced
3	D. E.	5 yrs.	Poor	Small shelf. Far above head (2 in.). Hip is reduced
4	D. E.†	7 yrs.	Good	Large shelf close to and covering head completely. Hip is reduced
5	A. R.	6 yrs.	Poor	Large substantial shelf but too high. Is 2 in. above head. Hip is reduced
6	F. C.	7 yrs.	Poor	Hip reduced. Shelf too high. Is 1⅓ in. above head
7	M. S.	8 yrs.	Poor	Shelf is large and massive but far too high. Lies 1½ in. above head. Hip is reduced
			BOTH SIDES SHELVED	
8	R. T.	8 yrs.	Good	Massive shelf, ¾ in. above head. Covers head completely. Hip is reduced
9	R. T.	8 yrs.	Fair	Large substantial shelf, ¾ in. above rim of primary acetabulum. Hip is reduced

* Same as Case No. 1.
† Same as Case No. 3.

All films in this and the unilateral group with the exception of M. H. were examined stereoscopically.

In only those cases (three unilateral and three bilateral) which may be considered good immediately after operation is it justified to judge the operation in terms of the end-results obtained. Comparison of Tables III and V of the unilateral group shows that immediately postoperative three were considered good and two were fair, while after one year only one good and two fair results are found. We are, therefore, particularly concerned with the final outcome in those individuals in whom the immediate anatomic result was satisfactory.

Three of our eight cases of unilateral luxation had open reduction with shelving in whom the immediate anatomic result may be judged as good. One had a fair result, making a total of four (50 per cent) satisfactory operations. The relentless march of the years, however, leaves even fewer good results (Table VII).

TABLE VII

THE EFFECT OF TIME ON INITIALLY SATISFACTORY RESULTS

Unilateral

Patient	Age at Time of Operation (in yrs.)	Immediate Anatomic Result	Final Anatomic Result	Observation Period (in yrs.)
C. L.	2	Good	Fair	1½
L. N.	5	Fair	Poor	1¼
R. A.	6	Good	Fair	3½
P. O.	11	Good	Good	3¼

In addition to those cases tabulated, there is the patient M. H. who is complicated by poliomyelitis. This case was shelved without reduction at the age of 16. The initial result was fair. Two years postoperatively there is no change. The initially poor results of course remained poor.

A similar comparison of the immediate and end-results in the bilateral cases reveals that the immediate anatomic result was good in three instances (33 per cent) and fair in one. In only one of these is the postoperative period greater than six months. It is still a good result; and represents the first shelf built in the case shelved bilaterally. The fair result was poor 5½ months postoperatively. It should probably have been considered poor from the start. The initial poor results naturally remained so (Tables IV and VI).

It is unnecessary that the data from each case be recorded. A few protocols are illustrative, however.

CASE PROTOCOLS

Case R. A.—This patient was first seen at the age of four because of a congenital dislocation of the left hip. Two futile closed reductions were attempted. At the age of six years open reduction with reaming out of the acetabulum and shelving was performed. The immediate operative result is considered good. After 20 months the hip started to subluxate (Figs. 1, 2, 3, and 4.)

Case C. L.—This patient was first seen at age of two months because of congenital dislocation of right hip, bilateral club feet and hands. Two futile closed reductions were attempted. At the age of two years an open reduction of the hip with a shelving was performed. The immediate operative result is considered good. Fifteen months later the hip is shown to be subluxated (Figs. 5, 6, 7, and 8).

Case R. T.—Complicated by Little's disease. Bilateral shelving performed at age of eight. First shelf only remains, two years postoperatively (Fig. 9).

The functional result which, after all, "is the proof of the pudding," closely parallels the anatomic findings (Tables VIII and IX).

In the seven cases of the unilateral group where the functional result is known, three poor anatomic results yielded poor function, while one poor shelving resulted in fair function. The two fair anatomic results allowed good and fair function, respectively; and the only good anatomic result has poor function.

In the bilateral group in which one side is shelved the functional result in five of the seven operations performed is known. In all five instances the

FIG. 1.—Two months postoperative.
FIG. 2.—Eight months postoperative.
FIG. 3.—Twenty months postoperative.
FIG. 4.—Three and one-half years postoperative.
FIG. 5.—Two months postoperative.
FIG. 6.—Five months postoperative.
FIG. 7.—Eleven months postoperative.
FIG. 8.—Fifteen months postoperative.

anatomic result was poor. One fair functional result occurred, the remainder were poor. The one patient with the fair function, however, reports a slow but steadily progressive return of her symptoms; and it is expected that she also must soon be classified as poor.

FIG. 9.—Two years postoperative.

TABLE VIII

FUNCTIONAL RESULTS OF SHELVING COMBINED WITH OPEN REDUCTION

Unilateral

Patient	Age at Time of Oper. in(yrs.)	Final Anat. Result	Observ. Period	Final Funct. Result	Observation Period
C. L.*	2	Fair	1½ yrs.	Undet.	
N. K.	4½	Poor	3 yrs., 9 mos.	Poor	4 yrs., 9 mos.
L. N.	5	Poor	1¼ yrs.	Poor	1¼ yrs.
J. R.	6	Poor	1 yr.	Poor	1 yr.
R. A.	6	Fair	3½ yrs.	Good	3½ yrs.
L. E.	6	Poor	1 yr., 9 mos.	Fair	6 yrs., 9 mos.
P. O.	11	Good	3¼ yrs.	Poor	3¼ yrs.
M. H.†	16	Fair	2 yrs.	Fair	2 yrs.

* Patient has bilateral club hands and feet. She is not at present ambulatory. She has walked since the shelving, however.

† Complicated by poliomyelitis.

The one case shelved bilaterally is complicated by spastic paralysis; and it is difficult to estimate the functional value of the operation. However, the side on which the shelf persisted is better than its mate where the shelf absorbed.

TABLE IX

FUNCTIONAL RESULTS IN SHELVING COMBINED WITH OPEN REDUCTION

Bilateral

No.	Patient	Age at Time of Oper.	Final Anat. Result	Observ. Period	Final Funct. Result	Observation Period
1	H. M.	4½ yrs.	Poor	1½ yrs.	Poor	1½ yrs.
2	H. M.*	5 yrs., 9 mos.	Good	1 mo.	Undet.	1 mo.
3	D. E.	5 yrs.	Poor	2 yrs.	Poor	2 yrs.
4	D. E.†	7 yrs.	Good	3 mos.	Undet.	3 mos.
5	A. R.	6 yrs.	Poor	1 yr.	Poor	1 yr.
6	F. C.	7 yrs.	Poor	2 yrs., 7 mos.	Poor	2 yrs., 7 mos.
7	M. S.	8 yrs.	Poor	5½ mos.	Fair	3 yrs.

* Same as Case 1.
† Same as Case 3.

PARALYTIC DISLOCATION.—In five cases of poliomyelitis in which unilateral dislocation of the hip occurred, three shelving operations were performed combined with open reduction. The initial and the final anatomic result in these cases is given in the Table X.

TABLE X

THE ANATOMIC RESULTS OF SHELVING IN CASES OF PARALYTIC DISLOCATION

		ANATOMIC END-RESULTS			
Patient	Age at Oper. (in yrs.)	Anat. Immed. Result	Anat. End-result	Post-oper.	X-ray Appearance at End of Observation Period
G. B.	6	Poor	Poor	6 yrs.	Shelf absorbed and small osteophytes are located at its site. Head in a secondary acetabulum
B. K.	7	Good	Poor	7 yrs.	Hip subluxated. Small shelf remains
E. R.	12	Good	Good	14 mos.	Shelf is substantial. Covers head entirely close to head
M. W.	14	Good	Good	4 mos.	Shelf close to head; completely covers it
A. B.	20	Good	Good	4 mos.	Shelf covers head entirely ½ above ant. rim, and is close to it. Hip reduced

It is to be regretted that later roentgenograms are not available in the cases operated upon after the tenth year.

The functional results in these individuals also closely parallel the anatomic findings (Table XI).

It is to be noted that in the case operated upon before the tenth year, in which the immediate anatomic result is good, the final functional and anatomic results are poor. The functional results in those cases operated upon later in life remained good as long as ten years postoperatively.

FIG. 11.—Fourteen months postoperative.
FIG. 12.—Six years postoperative.

FIG. 10.—Six months postoperative.

TABLE XI

THE FUNCTIONAL RESULT OF SHELVING IN CASES OF PARALYTIC DISLOCATION

Patient	Age at Time of Oper. (in yrs.)	Anat. End-result	Postoper.	Funct. Result	Postoper.
G. B.*	6	Poor	6 yrs.	Poor	6 yrs.
B. K.	7	Poor	7 yrs.	Poor	7 yrs.
E. R.	12	Good	14 mos.	Good	10 yrs.
M. W.	14	Good	4 mos.	Good	4 mos.
A. B.	20	Good	4 mos.	Good	2 yrs.

* The case of G. B. was complicated by progressive muscular dystrophy.

CASE PROTOCOL

Case B. K.—This patient was first seen at the age of three years because of old poliomyelitis with residual paralyses in the left leg. At the age of eight the left hip became subluxated. The instability was great and complete dislocation on very slight trauma was frequent. At this time a shelving of the hip with reduction was done. The immediate operative result is considered fair. After six years the hip is seen to be subluxated (Figs. 10, 11 and 12).

PATHOLOGIC DISLOCATION.—In six instances shelving was performed for pathologic dislocation of the hip. One had resulted from tuberculosis, and the others from osteomyelitis or suppurative arthritis. The interval between the last symptoms and operation, in cases of dislocation due to pyogenic infection about the joint, varied from ten months to 31 years. In the case of coxitis the interval between the last sinus about the joint and the operation was four years. The immediate and final anatomic results in this group are given in Table XII.

TABLE XII

THE ANATOMIC RESULT OF SHELVING IN CASES OF PATHOLOGIC LUXATION

No.	Patient	Age at Time of Oper. (in yrs.)	Interval between Inf. and Oper.	Anat. Result		Observ. Period (in yrs.)
				Immed.	Final	
1	R. H.	1½	10 mos.	Good	Poor	6
2	F. K.	5	3½ yrs.	Good	Fair*	4
5	A. F.†	16	4 yrs.	Good	Poor	8
6	A. H.	32	31 yrs.	Good	Good	1
3	B. R.	5	2 yrs.	Fair	Poor	3
4	M. B.	6	2 yrs.	Poor	Poor	2

* Hip subluxated.
† A. F. was tuberculous. In all the femoral head was partially or completely destroyed.

It is unnecessary to give the detailed data in each case, but it is to be noted that in only one instance was a good end-result obtained, and that this is present in the case with the shortest observation period. The functional results in this group are given in Table XIII.

FIG. 13.—One month postoperative.

FIG. 14.—Two years postoperative.

FIG. 15.—Four years postoperative.

TABLE XIII

THE FUNCTIONAL RESULTS OF SHELVING IN CASES OF PATHOLOGIC LUXATION

No.	Patient	Age at Time of Oper. (in yrs.)	Interval between Inf. and Oper.	Anat. End-result	Obs. Time (in yrs.)	Funct. End-result	Obs. Time (in yrs.)
1	R. H.	1½	10 mos.	Poor	6	Poor	6
2	F. K.	5	3½ yrs.	Fair	4	Good	5
5	A. F.	16	4 yrs.	Poor	8	Poor	9
6	A. H.	32	31 yrs.	Good	1	Good	5
3	B. R.	5	2 yrs.	Poor	3	Fair	3
4	M. B.	6	2 yrs.	Poor	2	Poor	8

In this group we find one fair and two good functional results. The slow progressive loss of the shelf or failure to maintain reduction is shown in the illustration.

Inasmuch as five of the six cases which were operated upon had initially good anatomic results but only one remained good for longer than one year, the shelf operation has not been of value in our experience in these conditions.

CASE PROTOCOL

Case F. K.—This patient was first seen at the age of five years because of a dislocation of the right hip due to an old suppurative arthritis. A shelving was done at this time. The immediate operative result is considered good. At the end of two years, however, the hip is found to be subluxated (Figs. 13, 14, and 15).

TRAUMATIC DISLOCATION.—Shelving has been employed in one case only. The shelf was placed over a fracture site in the acetabulum. A good result was obtained.

DISCUSSION.—If we disregard the cause and the type of the dislocation, we find that of the 29 shelving operations performed upon 27 hips, 15 were considered initially good and five initially fair results—a total of 20 satisfactory shelving procedures.

CHART I

THE EFFECT OF TIME ON THE SHELF OPERATION

(The figures represent the highest possible number of good results in our series of 18 cases)

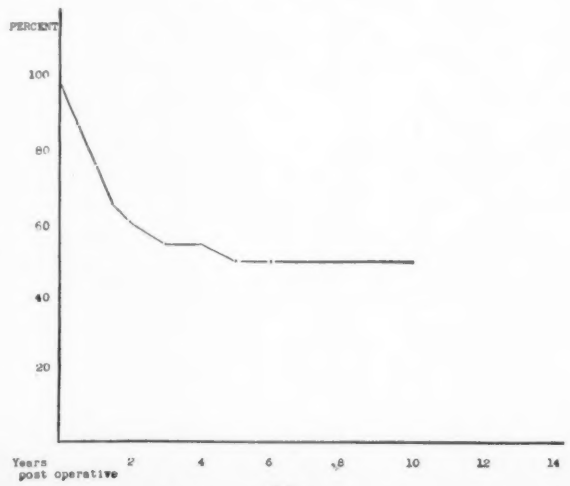

TABLE XIV

RESULT AT VARIOUS OBSERVATION PERIODS

Patient	Age at Oper. (in Yrs.)	½ yr.	1 yr.	1½ yrs.	2 yrs.	3 yrs.	4 yrs.	5 yrs.	6 yrs.	7 yrs.	8 yrs.	9 yrs.	10 yrs.
C. L.	1	Good	Fair	Poor									
L. N.	5	Fair	Poor	Poor									
J. R.	6	Fair	Poor										
R. A.	6	Good	Good	Fair		Fair							
P. O.	11	Good	Good	Good	Good	Good							
N. H.	16	Good			Fair								
R. T.	8	Good	Good	Good	Good								
R. T.	8	Fair	Fair	Poor	Poor								
N. L.	8	Poor											
B. K.	7	Good	Good	Fair	Fair			Poor	Poor				
E. R.	12	Good	Good	Good									
N. W.	14	Good											
A. B.	20	Good											
R. H.	1½	Poor	Poor		Poor								
F. K.	5	Good	Good	Good	Fair		Fair						
A. F.	16	Good			Poor	Poor					Poor		
A. H.	32	Good	Good										
B. R.	5	Fair	Fair			Poor							

Two cases are not tabulated since the postoperative time is less than six months.

The fate of these shelves and the steady progressive reduction of the numbers of good results is shown in Table XIV and Chart 1. In computing the percentage values, the last known roentgenogram was used in all cases so that all values obtained are based in each instance on the total series. Thus the figures represent the highest possible number of good results in the series. Since serial roentgenograms are valuable in all cases for only the first two years, the true values in the observation time of greater than two years are undoubtedly lower.

Table XIV also shows that in only six of 11 satisfactory operations performed before the tenth year did the anatomic result remain good or fair for longer than one year. Only two of these six are good at the end of two years. Two of the remaining four were initially good but became fair results at the end of two years.

We are unable to offer an explanation for this rapid deterioration of the anatomic results in those cases initially considered good. It is obvious that whenever there is sufficient disproportion between the size of the femoral head and the overhang of the shelf or acetabular roof, subluxation or dislocation will occur, depending upon the degree of disproportion. Such disproportion can arise in only two ways: First, by absorption of the shelf and, second, by growth of the head. In each film from every case the length of the shelf, transverse diameter of the head at the epiphyseal plate on the shelved and normal side, and distance of the shelf to the head was measured (Table XV). It is recognized that these measurements are open to several sources of error. However, the data obtained are interesting. We found that there is almost always a slight diminution in the length of the shelf in the first two to four months after operation. This sometimes progresses to complete absorption. Those instances where this occurred have been previously noted.

TABLE XV

RELATION OF SHELF LENGTH TO TRANSVERSE DIAMETER OF THE FEMORAL HEAD

Case	Time Postoper.	Shelf Length (in In.)	Transv. Diameter of Fem. Head (in In.)
R. A.	2 mos.	1 1/4	1
	8 mos.	1 1/4	1
	20 mos.	1 1/4	1 3/8
	3 1/2 yrs.	1 1/4	1 3/4
B. K.	6 wks.	3/4	7/8
	6 mos.	5/8	1
	14 mos.	5/8	1
	5 yrs.	5/8	1 1/2
	6 yrs.	5/8	1 7/8
F. K.	2 mos.	1 1/2	1/2
	2 yrs.	1 1/2	3/4
	4 yrs.	1 1/2	1 1/4

That growth of the head alone may be sufficient to change a good into a poor result is shown by the cases cited in the protocols.

In two of the three cases the procedure was extra-articular, in one it was intra-articular.* In all three the shelf length throughout the observation period remained constant, while the size of the head alone increased. All cases ultimately subluxated, and all cases were operated upon before the tenth year of life.

CONCLUSIONS

It seems from this series of cases that the shelving operation does not offer great probabilities of success when done before the tenth year of life. The series of operations (11) on which this is promulgated is admittedly too small to permit any dogmatic statement on this point. It is necessary that larger series be collected and the reports of different clinics be made available before this question can be settled.

In three of the five cases of paralytic dislocation for which a shelving was performed the functional results have been good for longer than two years. In one instance they remained good for ten years. We are unable to state what the anatomic result has been in these cases.

The anatomic and functional results in cases of pathologic dislocation have not been satisfactory except in one of the six cases shelved. This case has been followed for only one year postoperatively.

NOTE.—One case shelved with open reduction at the age of 15 has recently come to our attention. Fusion resulted from the operation. Patient now ten years postoperative and has considerable low back pain.

* Nineteen of the 20 shelves built in the total series were extra-articular; eight of these were initially good, seven initially poor, and four were initially fair results. There were two good and two poor intra-articular shelves built. In six instances we are now unable to state definitely whether the shelf was intra- or extra-articular.

BRIEF COMMUNICATIONS AND CASE REPORTS

AIDS IN SURGERY OF THE LIPS

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THE accompanying drawings and photographs are almost self-explanatory. While the methods described are original, as far as I know, yet it is felt that some of them must certainly have been used previously. Some of the chief causes of failures in lip surgery are hemorrhage, rough handling of tissues, and imperfect adjustments of wound edges especially at the vermilion border, and after operation, releasing of sutures, and infection. If the surgeon will carefully follow the points of operative and postoperative technic herein described, it is felt that these problems in large part may be overcome. While most of these points have been worked out from our experience with harelip, they will be found to apply almost equally well to all lip surgery.

Hemorrhage at Operation.—It is an interesting fact that most of the older text-books of surgery contain a warning that the surgeon should explain to the parents of a harelip subject that the operation is very dangerous because of bleeding. Davis in his text-book on plastic surgery says: "In the series of cases at the Johns Hopkins Hospital I note deaths from hemorrhage at the time of operation, and from postoperative bronchitis, pyelitis, and status lymphaticus." I state these facts to emphasize that hemorrhage has been a problem in lip surgery in the past. It must be kept in mind that even a relatively slight loss of blood may be of grave significance in the case of a debilitated child. Certainly, in any event, the child's blood should be grouped, matched and the bleeding and clotting time determined before operation. Since a relatively slight blood loss may turn the scales one way or the other, I have paid special attention for some years to methods of hemostasis. At first for control of bleeding of the labial artery I employed the usual flat compression clamps of various types. Later I felt that bidigital compression of the lip was less traumatizing. Recently each shoulder of the cleft lip has been transfixed with a fine cambric needle, carrying "A" silk, introduced from the skin side inward at a point well outside the usual oblique lines of incision and about half-way between the outer edge of the nostril and the vermilion border. The needle, with one half of the silk thread attached, was then brought back through the upper portion of the shoulder near the nostril edge from within outward. The free end of the thread thus drawn through was

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tied to the corresponding end so as to make firm compression on the upper part of the lip. The other half of the thread which had already transfixed the lip was brought around the free margin of the lip and the two ends as shown in the larger drawing were passed through the drill holes of a small stainless steel hemostatic clamp illustrated in Fig. 1. By proper adjustment of the tension on these threads before tightening the tap all bleeding may be controlled during the remainder of the operation without the slightest danger of cutting into the lip. The small hook on the outer surface of the clamp on one side of the periphery is designed to prevent medial slipping of the clamp. It should be placed as shown with the hilt of the hook outward

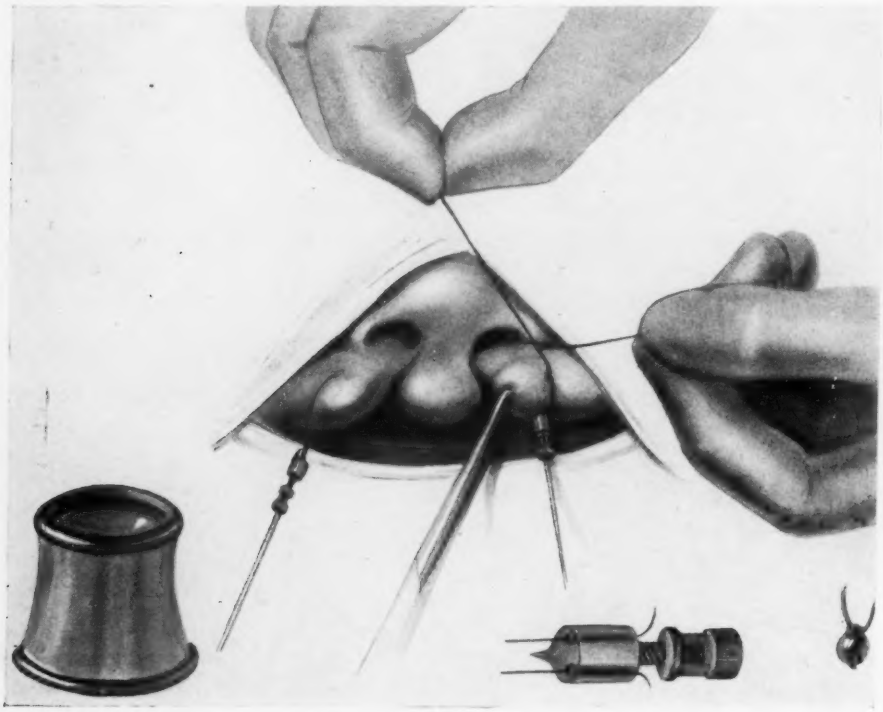

FIG. 1.—Illustrating the four points detailed of technic in lip surgery.

toward the lip angle but with the point of the hook perforating the free border of the lip in a medial direction. A little practice in applying the clamps will enable one to control hemorrhage completely. Fig. 1 shows the placement of the threads and clamps.

Handling of Tissues.—Once the two lip clamps are applied, they may each be grasped between the thumb and index finger. Thus the shoulders of the lip may be held and manipulated easily and securely during measuring of distances, cutting, adjustment of edges and suturing. It is rare that any other instruments such as hooks or thumb forceps will be necessary during the usual manipulations. The clamps avoid a great deal of direct handling

of tissues, thus decreasing trauma with consequent decrease of sloughing and infection. It might be argued that the transfixion of the lip itself adds trauma. This may be answered by saying that, in no case to date, of the several in which the clamps have been used, has any reaction at the transfixing points occurred. So small are the needles employed that the points of introduction on the skin have been difficult to find after the fourth day.

Imperfect Adjustment of Wound Edges.—Since there is no bleeding when the clamps are properly applied, the guide marks which have been measured off are clearly visible during and after incision of the shoulders. The vermilion border may be seen clearly and adjusted accurately. In order to aid in the accurate approximation of the edges, it has been found of advantage to employ the two times magnification afforded by a Beebe Binocular Loupe.

Releasing of Sutures.—On the lip, if a practice is made of tying sutures with a surgeon's knot and cutting the ends five to ten millimeters beyond the

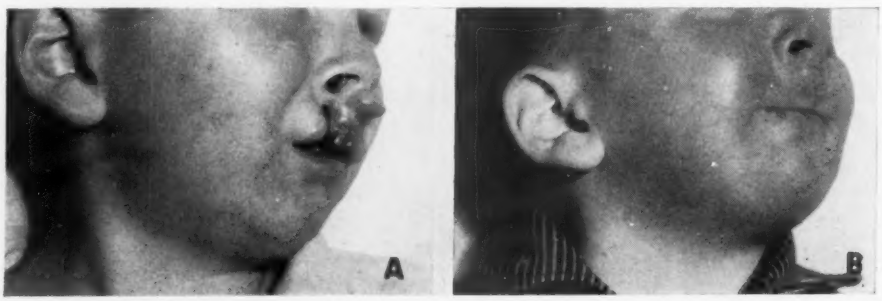

FIG. 2.—Result obtained in a double incomplete prealveolar cleft lip on which the tehchnic described in this article was employed. (A) Patient before operation. (B) Result one month after operation. No scars present at sites of perforation of hemostatic threads.

knot, the latter ends will hold blood clot and a scab will form over the suture line which will predispose to infection and to "cutting out" of sutures. To overcome this Blair has advocated putting as many as four or five ties to a knot. The ends are cut down to the knot. In order to accomplish the same result without the time consuming practice of tying each suture so many times, we tie each suture with the usual surgeon's knot and cut the threads down close to the knot, touching each one with a small drop of flexible collodion. Care must be taken not to spill the collodion on the fresh wound edges. As soon as the collodion has dried, the ends of the threads will be found to be "welded" together and a much smaller knot will result than if they had been tied four or five times (Fig. 1, right lower inset). The sutures will not become untied even though constantly bathed in saliva.

Infection.—We believe with Blair that a clean suture line is the essential factor in preventing infection of the wound after operation. We also cleanse the exudate from each suture at frequent intervals after operation, using a small jeweler's (Fig. 1, left) or other magnifying glass to enable this to be done with greater ease, twice a day, or oftener if necessary. After the mechanical cleansing of the sutures and wound the latter is bathed as Blair

advocates with equal parts of a saturated solution of boric acid and 95 per cent alcohol. These procedures have made wound infections very unusual in our experience.

Fig. 2 shows the result in a case of double incomplete cleft lip in which all of the procedures described were followed. This case may be taken as typical of many in which the same technic was used. The wounds from the transfixion sutures were not visible after the fifth day.

SUMMARY.—Several procedures in the technic of surgery of the lips are described. These seem valuable since by their employment the operation has been made almost bloodless, and the handling of tissues at operation and of the wound after operation has been made simpler. The results in several cases in which this technic has been followed have justified its use.

CARCINOMA OF THE BREAST WITH METASTASES TO THE THIGHS BY LYMPHATIC PERMEATION

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MANY experimental findings in cancer may often be seen clinically if one observes cases for a sufficiently long time. The theory of lymphatic permeation in cancer of the breast has not been proved satisfactorily in our laboratories, although it seemingly is a clinical observation in many instances. Unfortunately many of the cases exhibiting such phenomena are not recognized, and apparently only a small number of those which have been observed have been reported.

Handley,[1] who first propounded the lymphatic permeation theory, emphasized the importance of case reports, stating that "If the permeation hypothesis of dissemination is true, it should be possible to find some evidence in its favour among recorded cases of breast cancer which have been submitted to careful and systematic microscopic examination." In the case herewith reported, we believe there is definite clinical proof of the permeation theory to explain the metastases to the thighs. Because of its uncommon occurrence, Fitzwilliams[2] suggests that metastasis of this type is evidence against the permeation theory. He attempts to show that carcinoma of the breast spreads by embolism rather than by permeation, stating that "Wishing to make sure of my ground on this point, I wrote to Sir Charles Gordon Watson, Mr. Ernest Miles, and Mr. Lockhart-Mummery, to ask if they had ever seen secondary growths on the buttocks or thighs or elsewhere than in the glands of the groin. They were unanimous in saying 'No.' Is it not obvious then," he asks, "that cancer reaches the glands by embolism and not by permeation?"

The appended case report is cited, not only because of its rarity, but also

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because of its important bearing on the theory of lymphatic permeation. We believe this is a proved instance of lymphatic permeation. This opinion is concurred in by Dr. James Ewing, to whom we are grateful for his aid in studying the case.

Case Report.—C. B., a white female, married, age 46, was admitted to the Brooklyn Cancer Institute, February 1, 1935, for radiation, following a radical right mastectomy which had been performed four months previously in another hospital. The pathology of the removed breast showed a duct cell carcinoma with metastases to axillary lymph nodes (Dr. J. M. Ravid).

Physical Examination.—General condition good, weight 140 pounds. There was a systolic murmur at the apex and base of the heart, but the patient was in no way decompensated. Blood pressure 140/80, pulse 78, and of good quality.

The mastectomy scar was well healed, smooth, with no recurrences or palpable nodes in the axilla or supraclavicular region. The skin over the chest was smooth

FIG. 1.—Photograph showing metastatic involvement of both thighs.

FIG. 2.—Photograph of the patient six months after admission showing beginning of lymphedema of arm.

and freely movable. The arm was freely movable with no evidence of lymphedema. The left breast appeared normal. Roentgen therapy was administered over the chest and axilla, and a total dose of 5160 r given.

Four months later, June 28, 1935, she developed a tumor on the inner side of each thigh overlying the adductor muscles (Fig. 1). Each measured 2 cm. in diameter, and they were both firmly adherent to the skin and underlying structures. At this time the right axilla, right supraclavicular region and chest wall were free from any metastases or evidences of recurrence. Later, however, a small nodule developed at the site of the operative scar near the base of the right axilla.

The tumors in the thighs meanwhile increased in size to about 6 cm. in diameter. On September 12, 1935, an attempt was made to excise the tumor from the right thigh for diagnosis. When incised, it consisted of liquefied, necrotic yellowish-brown material, mixed with fragments of solid malignant tissue. Following incision 20 radon gold seeds were inserted into each tumor of the thigh and at the same time four radon seeds were inserted into the nodule in the right axilla. Histologic examination of the excised tumor by Doctor Polayes proved it to be metastatic carcinoma from the breast (Fig. 5).

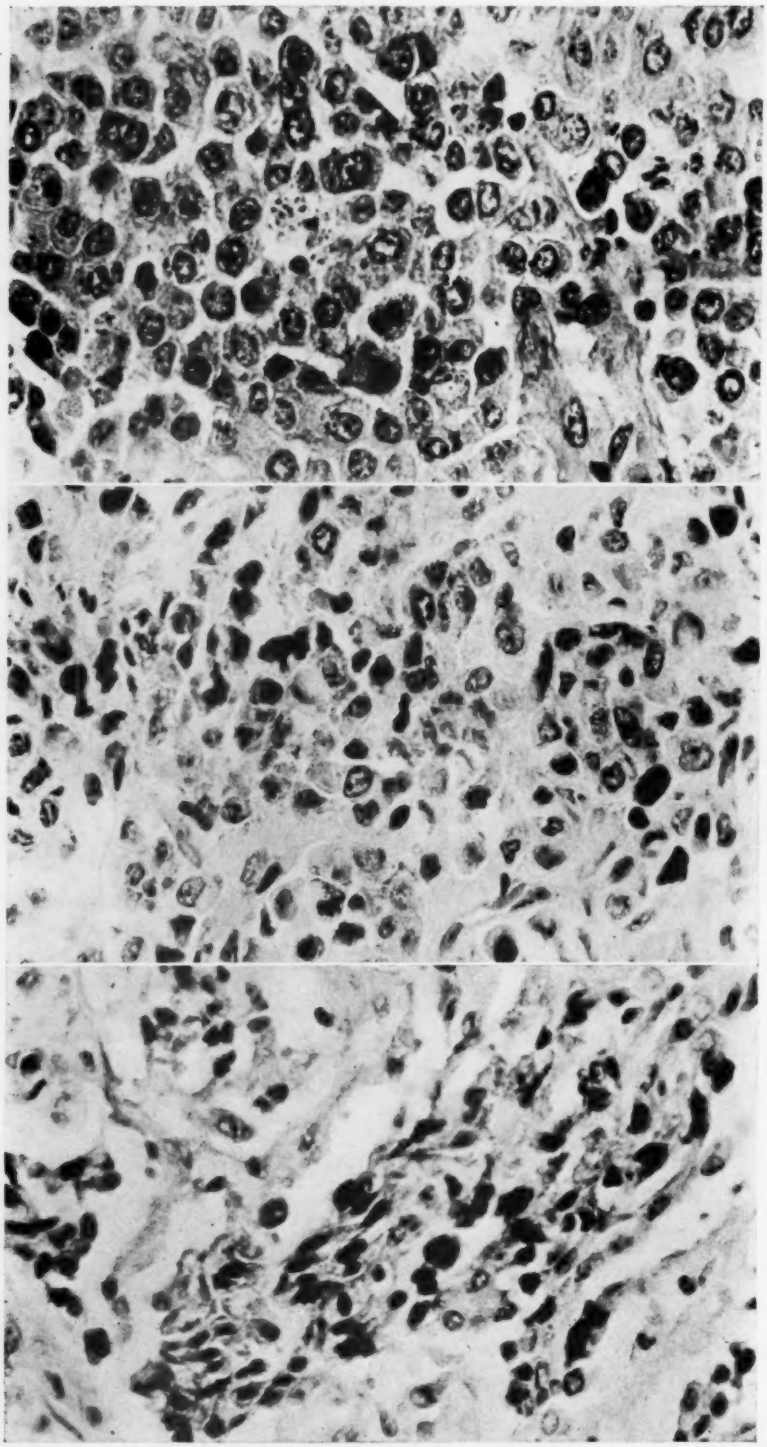

FIG. 3.—Photomicrograph of breast tissue (×970). FIG. 4.—Photomicrograph of axillary lymph node (×970). FIG. 5.—Photomicrograph of metastatic tumor of the thigh (×970).

One month following treatment the tumors of the thighs disappeared. Later a metastatic growth the size of an orange appeared in the right axilla, and a nodule measuring 3 cm. in diameter was found in the right supraclavicular region, followed very shortly by lymphedema of the right arm, (Fig. 2), which became progressively worse. The growths in the thighs reappeared, associated with numerous smaller nodules measuring about 1 to 2 cm. in diameter. These smaller nodules covered the entire right thigh and extended to the gluteal region. Approximately 35 covered the thigh and about 20 the right gluteal region. They were firm, hard and adherent to the skin, which was markedly indurated and of "pigskin" appearance. Numerous similar nodules were found over the right chest, shoulder, arm and axilla. Scattered nodules measuring 1 to 2 cm. in diameter were found over the abdomen. These extended for about 1 cm. into the skin and underlying structures. A tumor, the size of an orange, was felt in the left lower abdomen, freely movable, diagnosed clinically as a mesenteric metastasis.

Blood Wassermann was negative, the urine was normal, the blood count revealed a marked secondary anemia. The blood chemistry was within normal limits. Roentgenographic examination of both femurs, pelvis, spine, skull, ribs and lungs did not reveal any neoplastic changes. Roentgenographic examination of liver and spleen by injection of thorotrast did not reveal any metastatic growth. The gastrointestinal tract did not show any evidence of malignancy. Basal metabolism was plus 71.

On February 13, 1936, the patient became quite dyspneic and expired. At autopsy, performed by Dr. Harold Fink, there were found extensive metastases to the entire mesentery and omentum, right pleura and pancreas, and to the skin and thighs as already described.

SUMMARY.—Lymphatic permeation of cancer of the breast has not been proved satisfactorily in the laboratory, but can often be demonstrated clinically. The number of cases reported in the literature is very small because many such cases are not recognized and, if recognized, are not reported. A case of lymphatic permeation of cancer of the breast, which proves this theory, is herewith presented. It is hoped that this case report will contribute to the further study of the lymphatic permeation phenomena.

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CONGENITAL PYLORIC STENOSIS IN A SIX MONTHS' PREMATURE INFANT *

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CONGENITAL hypertrophic pyloric stenosis has been widely reviewed in the literature of recent years and is now regarded as a well defined clinical

* Read before the Philadelphia Academy of Surgery, April, 1935. Submitted for publication February 17, 1936.

entity. The following case report is of interest chiefly because we believe it to be a record of the youngest patient with pyloric stenosis successfully treated by operation. The nearest approach to it is a case described by W. E. Ladd, of Boston, in a personal communication, who reports operating upon a seven months' premature infant in 1930. His patient, one of twins, weighed three pounds 14 ounces when admitted to the hospital at the age of 12 days, upon whom operation two weeks later was successful. Weeks and Brooks[6] report a premature weighing four pounds at operation, but the age is not stated.

Case Report.—A colored female infant was born December 26, 1934, at the Philadelphia Lying-In Hospital. The mother had given birth to six other children, none of whom gave a history suggestive of pyloric stenosis. The infant weighed three pounds 8¾ ounces at birth, with a crown-heel measurement of 35.2 cm. The mother's menstrual history was vague, but the computed age of the baby was 6.8 lunar months according to formulae determined by Scammon and Calkins, of the University of Minnesota, in the work on the growth of the human body during fetal life.

The circumstances attending the child's birth were unusual. The mother, because of a nephritic toxemia, was delivered by cesarean section, as a life saving measure by Doctor Lull. The fetus and placenta were shelled out with the membranes intact. It was not until some moments later, when movement was noted in the basin containing the products of conception, that the sac was opened, and the child responded with a none too lusty cry.

The infant did very well until the twenty-eighth day, when she began to regurgitate feedings, bowel movements ceased, and in the course of three days she lost one pound in weight, returning to the birth weight of three pounds 8¾ ounces. At this time, 33 days after birth, she presented the classical symptoms and signs of pyloric stenosis, and a Rammstedt operation was performed by Doctor Lee, using local anesthesia supplemented with spirits of frumenti and paregoric. Except for the technical difficulties consequent to the size of the patient, no operative complications were encountered. Following the operation the child gained one pound in the first week on a Downes' formula. The wound, however, did not heal by first intention and, on the fourth day, separated revealing the surface of the right lobe of the liver. It was resutured, and the suture line supported with adhesive strapping. Healing took place slowly, but by the twenty-eighth postoperative day the wound was entirely closed, the patient had doubled her weight, and was ready for discharge from the hospital.

At this time she developed bronchopneumonia from which she survived, and was discharged 14 days later at the age of 98 days in good physical condition and weighing seven pounds.

One month following discharge from the hospital the child developed an upper respiratory infection and was readmitted with a bilateral otitis media necessitating myringotomies. She again made a satisfactory recovery and at the age of four months weighed eight and one-half pounds and was in good health but for a large congenital umbilical hernia.

When last seen, December 7, 1936, the child, age two years, weighed 23 pounds five ounces, was in excellent health, and exhibited no evidence of herniation either at the operative site or the umbilicus.

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ACUTE DIVERTICULITIS OF THE UTERUS

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DELEE[1] mentions that diverticula of the uterus, although rare, have been described. Sussig,[2] in reporting a case of placenta accreta in a uterine diverticulum, discussed the question as to whether such diverticula were congenital or acquired. The following is a case of acute inflammation in what appeared to be a congenital diverticulum of the uterus.

Case Report.—The patient, age 24, was a nulliparous, married woman. Menstruation began at the age of 12. The menstrual periods were regular, occurring every 28 days, of six days' duration, and were always preceded by pain. During the two periods previous to the present illness the flow had been very profuse. The present menstrual period began May 21, 1935, and was associated with cramp-like pains in the lower right quadrant which increased in intensity and frequency until May 25, when it was necessary to administer morphine. The patient was admitted to the hospital in a state of exhaustion following a nine hour automobile trip of 90 miles over very rough roads.

Upon admission to the hospital on May 26, bimanual examination disclosed a mass in the right broad ligament which was thought to be a tubal pregnancy. Examination of the urine was negative. The leukocyte count was 13,450, 86 per cent polymorphonuclears and 14 per cent were lymphocytes. It was considered best to keep the patient under observation until she had had a chance to recover from the tiring trip. Twelve hours after admission, the leukocytes were 7,750, 74 per cent polymorphonuclears and 26 per cent lymphocytes.

Operation.—It was thought advisable to explore the mass in the right lower quadrant, and under general anesthesia an incision was made in the lower midline. Between the layers of the right broad ligament midway between the isthmus of the fallopian tube and the uterine cervix there was a mass 2½ x 2 x 1½ cm. (Fig. 1). It was firm and showed definite evidence of recent inflammation, and was attached to a nulliparous uterus by a very small pedicle, and was therefore considered a diverti-

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culum of the uterus. The pedicle was divided between forceps applied close to the uterus. It was impossible to separate the diverticulum from the inferior border of the

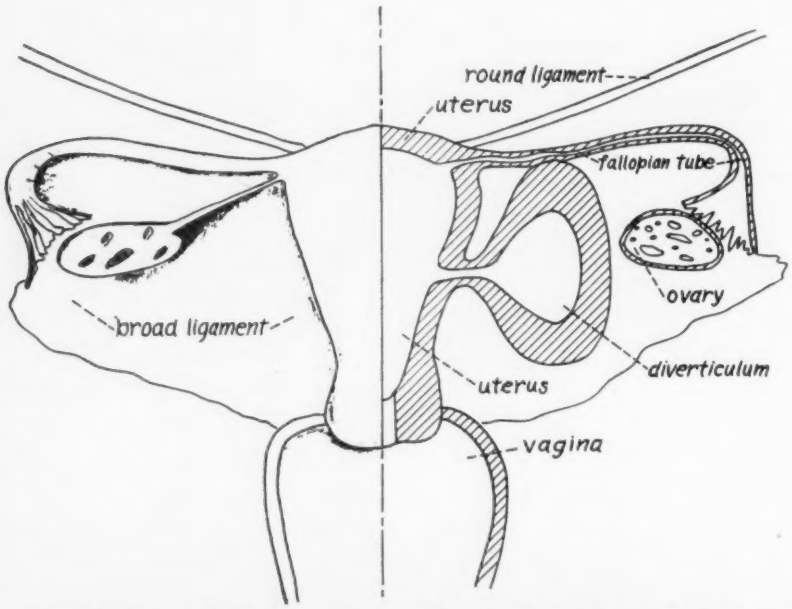

FIG. 1.—Schematic drawing of the uterus, tubes, ovaries and vagina, showing the diverticulum of the uterus adherent to right fallopian tube.

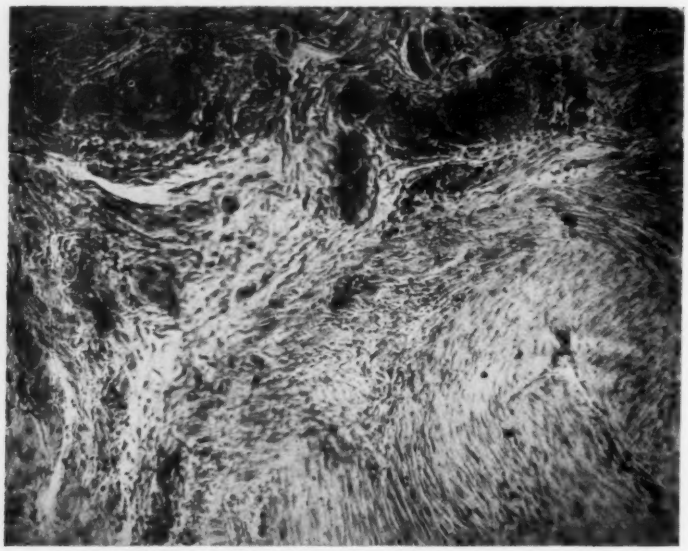

FIG. 2.—Photomicrograph of the wall of the uterine diverticulum, showing unstriped muscle, considerable connective tissue and throughout an infiltration of monocytes and polymorphonuclear leukocytes (×80).

right fallopian tube and therefore it was necessary to perform a right salpingectomy, peritonealizing the stump of the tube. The abdomen was closed without drainage.

Pathologic Examination.—Section through the diverticulum showed the wall to have the same appearance as the uterine wall and with a central cavity ½ cm. in diameter, which was filled with hemorrhagic, purulent exudate (Fig. 2). *Microscopic* examination showed the wall of the diverticulum to be made up of an external peritoneal layer, smooth muscle, considerable connective tissue and throughout an infiltration of monocytes and polymorphonuclear cells. *Diagnosis.*—Uterine diverticulum with an acute and chronic diverticulitis.

The patient made an uneventful recovery and was discharged from the hospital on the eleventh postoperative day. The patient was last seen April, 1936, at which time she was in excellent health with the exception of the usual premenstrual pain.

SUMMARY.—A case of acute inflammation of an apparently congenital diverticulum of the uterus is described in which the diverticulum was excised. As far as I have been able to learn from a review of the available literature, this type of surgical procedure has not been reported previously.

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ENCAPSULATED, NONSUPPURATIVE SUBPHRENIC GAS PERITONITIS

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IN A search of the literature since 1916 I have been able to find only two cases[1,2] of nonsuppurative encapsulated gas peritonitis. In these, however, the lesion was not situated beneath the dome of the diaphragm, and the cases differed in other respects from the one here presented.

Case Report.—A. M., female, age 20, was admitted to St. Luke's and Children's Hospital, July 21, 1935, with a diagnosis of acute appendicitis. Temperature 99.3° F., pulse 122, respirations 24. The fever continued until July 26, when under morphine, atropine, nitrous oxide and oxygen the appendix was removed and a right ovarian cyst resected. The appendix was normal. On the second postoperative day the patient complained of some pain on motion at the extreme right hypochondrium; and on the sixth postoperative day pain in this region on breathing. The immediate postoperative temperature was 99.2° F., but it was noted that there was some pallor and that the pulse rose to 150, but subsequently fell to as low as 100, although the temperature rose gradually until it reached 102° F. on the seventh postoperative day.

On admission the hemoglobin was 70 per cent and the red blood cell count 4,500,000, but the blood count declined so that by the tenth postoperative day the hemoglobin was 45 per cent, the red cell count 2,560,000; leukocyte count 23,400 with 90 per cent polymorphonuclears. Slight jaundice was apparent.

On the seventh postoperative day physical examination revealed the following:

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There was tenderness in the right hypochondrium and left costovertebral angle; vocal fremitus was present at both lung bases; there was some impairment on percussion at the bases, with distant breath sounds of normal pitch. The heart was in normal position; abdominal signs for fluid were doubtful; there was no especial abdominal rigidity; respirations were 32. On the ninth postoperative day a roentgenogram of the chest revealed a high diaphragm on the right side with some blurring and accentuation of all the lung markings; the left hemathorax was slightly denser than the

FIG. 1.—Anteroposterior roentgenogram taken on the forty-first postoperative day, showing encapsulated gas under right dome of diaphragm.

FIG. 2.—Lateral roentgenogram taken on the forty-fourth postoperative day, showing encapsulated gas under the upper (right) dome of the diaphragm.

right. The roentgenologic diagnosis was hypoventilation on the right side (so-called partial atelectasis), and edema of the pleura on the left side.

The patient's condition continued unchanged and on the twelfth postoperative day under nitrous oxide-oxygen anesthesia the abdominal incision was reopened. A considerable amount of foul smelling blood was evacuated; the abdominal operative site was not inspected. Drainage was instituted. The term "postoperative" will now be used to refer to the second operation. The breath sounds at the bases again became diminished, but some diaphragmatic motion could be detected and vocal fremitus was present. On the seventeenth postoperative day there was noted anteriorly an area of tympany with its center in the midclavicular line at the fifth rib. Subsequently it was possible to percuss this area to some extent posteriorly. Above the area the lung was hyperresonant.

Roentgenologic examination on the twentieth postoperative day revealed an area of air beneath the right diaphragm about the size of a lemon. Physical signs continued about the same; on the forty-first postoperative day roentgenologic examination showed the gas to be apparently encapsulated and about the size of a small apple (Figs. 1 and 2). The patient's temperature had gradually declined and had become normal by

the twenty-fourth postoperative day. The patient was discharged on the forty-ninth day at which time some tympany could still be detected. The patient was seen in the out-patient department on the sixty-ninth day, at which time there still remained physical signs at the right base resembling a previous pleurisy. Roentgenographic examination of the chest at this time was normal.

COMMENT.—A number of difficulties attend the diagnosis of postoperative chest and abdominal reactions; the difficulty is increased if a suppurative abdominal disease has been present preoperatively. The majority of operated patients show the so-called partial pulmonary atelectasis, or postoperative hypoventilation.[3] The exact sequence of cause and effect has not been entirely determined. The diaphragm is higher than normal, which may be due to intestinal distention. Beecher[4] has shown that after celiotomy there is a decrease of lung volume. With this partial atelectasis there is sometimes fever, often frequently accompanied by cough and pain; the physical signs resemble somewhat those of pleurisy or pneumonia.[5]

In the following discussion, the question of air and gas in the intestines and peritoneal cavity will be considered in general; not all of these conditions would require to be differentiated in a given patient, and some of them would require only preoperative differentiation.

DIFFERENTIAL DIAGNOSIS.—(1) *Generalized Abdominal Distention and the Liver Dulness*: A certain amount of obliteration of the lower part of the liver dulness is the rule postoperatively; it is probably due to intestinal distention and the tympany over the lower hypochondrium does not reach the degree seen after extensive liver atrophy.

(2) *Localized Distention of the Right or Left Colon.*—This occasionally occurs postoperatively[6] or independent of operation.[7] The upward displacement of the hollow and solid viscera is such that the physical signs resemble pyopneumathorax, and patients have occasionally been subjected to celiotomy on account of this error.[8]

(3) *Persistent Postoperative Subdiaphragmatic Air.*—Air persisting under the dome of the diaphragm, presumably admitted during the course of an ordinary celiotomy, is not extremely rare. According to Götze,[9] it is usually absorbed in 96 hours; but occasionally it may persist for three to four weeks, in which case it may be erroneously diagnosed as indicative of a subphrenic pyopneumathorax.[10] Air may also persist after special procedures, or accidents, such as inflation of the fallopian tubes, laparoscopy, pneumathorax, interstitial emphysema, *etc.*

(4) *Hepatoposis.*—A number of cases have been reported in which, with rotation of the liver, coils of intestine have found their way above the liver.[11] This condition has also been mistaken for rupture of a viscus or a subphrenic pyopneumathorax.

(5) A rare condition of emphysematous-like bubbles on the diaphragm,[12] analogous to the same condition found in the intestinal serosa (pneumatosis

cystoides intestinii).[13] The following would also, at times, require differentiation:

(6) *Subdiaphragmatic Air Due to Perforation of a Viscus.*[14]

(7) *Subphrenic Abscess* (subdiaphragmatic pyopneumathorax).

(8) *Infected Liver Abscess with Gas,* near the surface of the liver, including infected hydatid cyst.[15]

(9) *Localized Pneumathorax* or *Pyopneumathorax,* including the interlobar form, and large lung cavity.[16]

(10) *Dextrocardia, Eventration of the Diaphragm, and Diaphragmatic Hernia,* would require preoperative differentiation.

(11) For the sake of completeness may be mentioned that peculiar condition of generalized abdominal distention due to gas in the peritoneal cavity (outside of the intestines), called by the French spontaneous pneumaperitoneum,[17] by the Germans tension pneumaperitoneum.[18]

(12) *Localized Encapsulated Gas Area,* nonsuppurative in character, which, as in the case reported, seems to be rare.

(13) *Subcardiac Diverticulum of the Stomach* must be differentiated from subdiaphragmatic lesions such as air in the colon, perigastritis, *etc.*[19]

It must be emphasized that the case herewith detailed was essentially a nonsuppurative subdiaphragmatic peritonitis. These cases run a septic-like temperature and present a leukocytosis, and hence resemble a subdiaphragmatic abscess. That nonsuppurative cases are not so very unusual has been amply demonstrated by Neuhof,[20] who reported 15 instances, and by Lee,[21] who cites four cases. As a matter of fact, nonsuppurative subdiaphragmatic peritonitis was discussed as long ago as 1897 by Box and Russel.[22] It may be argued whether the gas in the present case was admitted during the operation or whether it was a result of bacterial action. Unfortunately a culture was not taken. In the case of Hegner,[2] an atypical Clostridium welchii was found. The fact that the gas in this case was encapsulated speaks, at least, for an inflammatory reaction; its apparently late appearance also points to the same conclusion.

SUMMARY AND CONCLUSIONS

(1) A case of encapsulated gas under the dome of the diaphragm is described. No similar instance was found in the literature.

(2) The condition was due to a nonsuppurative, subdiaphragmatic peritonitis, which has been previously described by Neuhof and by Lee.

(3) The significance of gas in the peritoneal cavity is discussed; as well as of other conditions which may resemble peritoneal gas.

(4) Free or encapsulated gas in the peritoneal cavity postoperatively does not necessarily signify suppurative peritonitis or perforation of a viscus; a diagnosis of these conditions must be made on a consideration of all the symptoms.

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PROXIMAL LIGATION AND EXCISION OF VEINS FOR SEPTIC PHLEBITIS *

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PROXIMAL ligation for septic phlebitis is not new in surgery. John Homans, in 1928, advised ligation and excision of thrombosed varicosities, and Harvey Stone, in 1932, read a paper before the American Surgical Association on this subject. I remember a case upon whom Doctor Pool, in 1925, performed a proximal ligation of the internal saphenous vein for sepsis.

The ligation and excision, or ligation and incision, of suppurative phlebitis has been effected in many superficial veins, and this procedure has also been employed in instances of jugular vein sepsis following mastoiditis. However, not much has been written of the ligation of the major veins, such as the axillary or the external iliac. It seems worth while, therefore, to report the proximal ligation in two illustrative cases—one of the axillary and one of the external iliac vein.

The first case was seen in consultation with Dr. William Johnson, at the Fifth Avenue Hospital. Doctor Johnson performed the operative procedure, but I was privileged to see the case in consultation and to assist him.

CASE REPORTS

Case 1.—Mrs. D. S. The primary condition was an infection which began in the anterior closed space of the right thumb. At the time of admission to the hospital, September 21, 1936, there were collections of pus in the distal and proximal phalanges of the thumb and in the thenar space. There was a brawny induration of the anterior surface of the wrist, a spot of brawny induration the size of a fifty cent piece in the antecubital fossa and streaks of lymphangitis running to the shoulder.

Successive operations to permit drainage were performed, so that by the time the condition now under discussion arose, incisions had been made in the distal and proximal phalanges of the thumb, thenar eminence, wrist, and hypothenar eminence.

By October 19 the infection had seemingly been brought under control. Suddenly, however, the temperature jumped to 103° F. and in the space of 12 hours the thumb and thenar eminence had doubled in size, become tense, and bluish-red in color. This was considered to be an acute exacerbation of the infection, and that in order to save the proximal phalanx of the thumb by adequate drainage, the distal phalanx would have to be sacrificed. Amputation through the interphalangeal joint was effected, but no pus was found. Incisions were then made in the proximal phalanx and thenar spaces to relieve tension. This then was believed to be a circulatory phenomenon—probably a venous thrombosis.

The following day the swelling had increased and was also present in the hypothenar space. The temperature reached 106 ° F. Dr. Hugh Auchincloss was called in consultation and believed that pus was present in the thenar and hypothenar spaces. In compliance with his recommendations, operation was performed the following morning, October 12. The tissues were tense, pale, and wet. Only one small collection of inadequately drained pus was found at the base of the little finger.

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By evening the temperature had risen to 106.6° F. Examination showed a red streak running up from the brawny spot in the antecubital fossa to the axilla, over the course of the basilic vein. The vein could easily be felt as a tense cord. The end of the thrombus could be felt at the anterior axillary fold. Immediate operation was performed under local anesthesia and the axillary vein ligated above the clot.

The peak temperatures immediately began to decrease and steady improvement was noted until October 22, when the temperature again jumped to 105° F. Simultaneously the red area in the antecubital fossa extended down the forearm for about two inches, and a streak began to ascend the arm over the cephalic vein. Conservative measures were employed and the advance of this streak carefully watched. Fortunately, it receded spontaneously the following day.

After October 23 the temperature did not rise again above 100° F. Improvement was steady and continuous, and the patient was discharged from the hospital November 21, 1936.

Case 2.—Seen in consultation with Doctors Ingraham and Chapman, September 29, 1936. Mrs. K. W., age 37. C. C. Persistent phlebitis left leg. P. H. Negative save for fracture of the right ankle in April, 1922, and of the left ankle in November, 1922. Married June, 1927. Delivered of her first child June, 1928—normal pregnancy and delivery. September, 1928, swelling in the left leg from the knee to the ankle, gradually extending up the thigh. Diagnosis: Secondary phlebitis. Elevation of the leg as much as possible, and an elastic stocking was advised. Chronic swelling persisted until the beginning of her second pregnancy, August, 1929, when all symptoms disappeared.

She was delivered of twins prematurely in February, 1930. There was no sign of phlebitis until three months later, when the swelling began in both legs. However, a third pregnancy was started in July, 1930, and again all signs and symptoms of the phlebitis disappeared. She was delivered of her fourth child (the third pregnancy) February 24, 1931. In May, 1931, both legs became swollen and exceedingly painful. Doctor Chapman ordered her to bed, with feet elevated. The temperature remained at about 101° F. for a month. The right leg resolved very quickly but the left leg remained painful, although the swelling subsided. The pain extended to the left pelvis and groin. She was in bed from May 22 to November 21. The condition from November 21 was uneventful except that the leg became swollen at intervals and she wore an Ace bandage almost constantly.

At the onset of the fourth pregnancy, in August, 1934, all the swelling and discomfort again disappeared. She was delivered of her fifth child (her fourth pregnancy) April 28, 1934. There were no acute signs of phlebitis following this pregnancy. She again wore an Ace bandage for swelling, especially during the warm weather.

In April, 1936, acute symptoms again became evident, with extreme pain and inability to walk. She was seen by Doctor Chapman, and was put in bed, with the foot of the bed elevated six inches. From April 4 until the time of her operation on December 30, 1936, she ran a constant elevation of temperature averaging about 102° F. The leg was extremely painful and swollen. At one time she had a chill, followed by pain in the chest and a cough. It was thought to be occasioned by a pulmonary embolus. She was given sodium thiosulphate intravenously from the first of July, which did not influence the height of the temperature. Her blood clotting factors, taken in August, 1936, were: Plasma clotting, 1.3; fibrinogen, 0.055. She was again given sodium thiosulphate intravenously the latter part of August, and at that time her temperature receded and it was thought she was going to improve, but a second series, given the second week in September, caused the temperature to rise again to 104° F.

I saw her first, in consultation, September 29, 1936. The patient was an obese woman of 37, weighing 220 pounds. Her face was flushed and she appeared acutely ill. Her leg and thigh were swollen and extremely tender. Vaginal examination revealed a tender vein up along the pelvic wall. There was some tenderness suprapubically

in the left lower quadrant. It seemed to me she had a phlebitis extending well up beyond Poupart's ligament. From the history one might assume that the phlebitis or periphlebitis had at one time extended upward to the bifurcation of the vena cava because in two different attacks she had transient swelling and pain in the right leg. She had also had a left lower abdominal quadrant pain which quite suggested inflammation of the deep epigastric vein. Following the vaginal examination her temperature became elevated again and she had more pain in her leg and pelvis. She was given 50 cc. of 0.5 per cent aqueous solution of gentian violet intravenously October 13, at my suggestion. No result accrued therefrom. From then on her temperature was elevated to an average of about 103° F. every afternoon. I saw her again December 10, 1936. During the intervening time I had corresponded with Dr. John Homans, of Boston, concerning whether or not a proximal ligation of the vein should be undertaken. He suggested that it would be advisable, not so much for the ligation of the vein as for the interruption of the lymphatics which were probably the cause of the reinfection. She was finally transferred from Scarsdale to the New York Hospital, December 28. On the day of her transfer her temperature did not become elevated but her pulse was around 130.

On admission there was a sense of resistance in the left lower quadrant and I felt that perhaps there might be a retroperitoneal abscess. The following day her temperature was elevated to 101.4° F. She was operated upon December 30, 1936.

During the time she had been ill she had had a number of blood cultures which were negative. Her blood count on admission to the New York Hospital was 18,880, with 86 per cent polymorphonuclear leukocytes. Blood chemistry: Urea N. 8, sugar 88, cholesterol 299. Clotting factors: Prothrombin 0.95, fibrinogen 0.65, platelets 420,000, lysis 26. Urine: Negative.

Operation.—December 30, 1936. Under the anesthetic the resistance in the left lower quadrant disappeared and no mass could be felt. The peritoneum was opened through a left paramedian incision and the uterus and ovaries palpated. Nothing abnormal was felt. The peritoneum was closed. The posterior sheath of the rectus at its lateral border was incised and the peritoneum was retracted mesially, exposing the bifurcation of the common iliac and the left ureter. The external iliac vein was isolated about 4 cm. beyond its bifurcation. It was adherent to the surrounding structures, and the wall felt thickened but it did not contain, as far as one could tell, a thrombus. It was ligated between ligatures and a piece of the vein about 1½ cm. was removed for miscroscopic study. Unfortunately, no culture was taken.

Pathologic Examination.—There was no thrombus. In the vein excised the intima appeared normal. Numerous cocci and an occasional bacillus were seen in the lymphatics of the adventitia and in many sections of the vein. This finding would tend to substantiate the statement of John Homans, of Boston, who believes that the benefit derived from ligation is very largely due to the interruption of the lymphatic chain in the adventitia rather than by the ligation of the vein itself. He found in his experimental work that the swelling of the leg, such as is seen in an acute thrombophlebitis, was not produced in animals by ligation of the vein but could only be created if the lymphatics were interrupted. It would seem then that the swelling noted in cases of thrombophlebitis in adults is in great part due to the periphlebitis.

The postoperative course was uneventful, other than that she did not secrete much urine until her fifth postoperative day. She developed a parotitis on the 6th postoperative day, which was incised and drained. Thereafter her temperature remained at normal and she was allowed out of bed on her 20th postoperative day. The left leg while in bed remained about the same size and color as the right. On sitting up, however, the left calf and thigh were each about two inches larger than the right. At first she had some difficulty in walking, the result of her having been in bed for ten months. The pain in the thigh disappeared on the third postoperative day, and she has had no tenderness over the vein since this time.

CONCLUSIONS

Proximal ligation of large veins in cases of suppurative phlebitis is advisable in certain instances. The benefit derived therefrom may be largely due to the interruption of the perilymphatic channels which accompany the vein. The study of the section of vein removed in Case 2 would seem to substantiate this inference.

EXCISION OF VEIN FOR SUPPURATIVE THROMBOPHLEBITIS*

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Case Report.—Mount Sinai Hospital No. 306875. W. M., age 40, fell and sustained an abrasion over the left elbow. When seen two days later, it was noted that the wound had become infected, that an axillary swelling existed, and that the skin overlying the axillary swelling was of erysipeloid appearance. On the third day the patient was distinctly toxic, with flushed face, was feverish, but was free from pain. The axillary swelling was somewhat more obvious. The arm could be abducted only with difficulty; but when abducted the swelling appeared to roll out of the axilla. There was no fluctuation. A blood culture was taken. Throughout the four days previous to admission, fever was present ranging from 103° to 105° F., but had not been accompanied by chills. On admission, four days after the injury to the elbow had occurred, the patient appeared septic, was apathetic, and was no longer flushed but rather pallid. There were herpetic crusts on the upper lip. Perhaps because the patient was a heavily built man the axillary swelling was not obvious until the arm was abducted. It was firm, tender, nonfluctuant. The spleen was not palpable. The blood culture, which had been taken before admission, was negative and remained so.

Diagnostically a subpectoral abscess could be assumed to exist even in the absence of fluctuation. Although patients with subpectoral abscess may be gravely ill, the progression of events in this case together with the septic appearance of the patient led us to believe that in all likelihood a complicating phlebitis of the axillary vein existed (even though the blood culture was negative). The operative plan was to proceed with the exposure of the axillary vein even if a large axillary abscess was encountered.

Operation.—An incision was made across the anterior axillary fold ultimately severing the pectoralis major almost completely. Several large collections of pus were encountered beneath the pectoralis muscle. There was relatively little involvement of the axillary lymph nodes. Indeed, the latter lay for the most part in septa separating various suppurative areas. As the septa were traversed, additional suppurative zones were entered. In short, practically the entire axilla was the seat of a suppurative process. This very extensive suppuration could account for the clinical picture. However, the plan of exposure of the axillary vein was adhered to. A suppurative plane led to the sheath of the axillary vein. In the region of the teres major there was encountered a small thrombosed vein which extended upwards to, or into, the axillary vein. Following this as a lead, the vein was exposed by incising the overlying sheath. It was bluish in the lateral aspect of its third portion, but as its midportion was approached it became whitish in appearance and a firm resistant mass in its interior could be felt. This was obviously a thrombus about half an inch long.

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Mesial to the thrombus the vein was still discolored; it presented its normal, or approximately normal, bluish hue only in the first portion near the apex of the axilla. After the exposure of the vein had been effected, branches were tied off and the vein was then excised between a ligature placed high up in the axilla and one at the brachial vein. The wound was packed.

Pathology Examination.—Gross: the specimen was opened longitudinally, and revealed a grayish, adherent thrombus with a more recent red clot attached to its mesial end. It was about 2 cm. long with an irregular surface, and was firmly adherent to the wall of the vein. The adjacent intima appeared inflamed. The thrombosed branch above referred to entered the vein directly adjacent to the thrombus. *Microscopically* an acute suppurative thrombophlebitis of the axillary vein was demonstrated. The perivascular tissue also revealed acute purulent inflammation. Gram-positive cocci were found in the thrombus.

Improvement began promptly after operation. The pulse rate became slow, and the general appearance improved. The temperature fell rapidly, and was below the 100° level at the end of the first week, and normal at the end of the second week. The wound cleaned up rapidly and was healed after several weeks. No metastatic foci have appeared. It is now five months since operation. There is no appreciable interference with function. The absence of edema of the upper extremity should be noted. Edema of the arm was never present at any time after operation.

At the present time there is certainly no standard view on the question of procedure in cases of suppurative phlebitis of large venous trunks in which there is accompanying septic invasion. According to some, a positive blood culture and the picture of septicemia may be derived from a suppurative lesion without any associated thrombophlebitis. In my own experience and according to personal observations, a phlebitis of an important venous trunk in the immediate neighborhood of the suppurative process has been demonstrable in almost all cases. Again there are those who concede a suppurative thrombophlebitis but believe it may take care of itself if the abscess from which the phlebitis is derived is adequately drained. That this can be true, and that it occurs at least occasionally cannot be questioned. We have all seen cases in which there could be but little doubt as to the existence of a thrombophlebitis because metastatic foci had appeared and yet recovery had ensued without any surgical attack on the thrombophlebitic process. Indeed, such surgical attack may not be possible in certain regions. However, the fact remains that there are many cases of suppurative thrombophlebitis involving venous trunks of appreciable size in which drainage of the adjacent abscess in no way influences the septic course. It is proper to question, I think, if we show good judgment in standing by and doing nothing more than draining the abscess. My purpose in presenting this case is to make an appeal for at least the exposure of the venous trunk in the region of the abscess in cases in which there is the clinical evidence of septic invasion and usually a positive blood culture as well.

There is certainly no serious difficulty in the recognition of the presence or absence of a suppurative thrombophlebitis if the main vein in the region of the abscess is exposed by an operative incision. What the next step should be if a suppurative thrombophlebitis is disclosed is open to discussion. My own view is that there is no reason for withholding excision of

the vein bearing the infected thrombus because any procedure short of this may not be sufficiently radical to eradicate the source of the septicemia. The case herewith presented, and others which I have demonstrated upon previous occasions, definitely establish the fact that excision of main venous trunks of the extremities is not followed by edema.

Discussion.—Dr. Paul Klemperer (New York) emphasized that the success of surgical intervention in a case similar to that described by Doctor Neuhof depends on two factors: First, the extent of bacterial dissemination that has already taken place; and second, the possibility of limiting the process and preventing further bacterial distribution. If one considers the development of suppurative thrombophlebitis in cases of this type, the chief way in which the phlebitis develops is by periphlebitis which, in the present instance, was present—and is usually present, except in traumatic cases where the infection of the vein takes place by direct contact with infected material. It is first periphlebitis with infection of the adventitia and penetration of the venous wall; only then does a thrombus form, the thrombus being secondary to the infection of the venous wall and not primary. There are a few cases in which no thrombus forms, or in which the veins can be examined before it forms. But there is generally thrombophlebitis after the infection has reached the inner coat of the vein. Therefore, if it is desired to prevent progress of the process one must start by trying to combat the infection of the venous wall. Ligation of the vein in thrombophlebitis can only prevent the spread of bacteria into the circulation. It cannot prevent the spread of the process within the wall.

The possibility that thrombophlebitis may limit itself must be granted. Ligation of the vein beyond the thrombus so that bacteria are prevented from entering the circulation gives a gain of time for spontaneous limitation of the thrombophlebitis. However, one has to consider that the collateral veins empty into the circulation and the only rational way to handle the situation—if one wishes to prevent spreading of the process—is to attack it radically and resect the infected vein, without leaving it to chance for the process to become self-limited. Doctor Klemperer said that it would not be in order for him to speak of the frequency with which thrombophlebitis actually occurs in cases of suppuration because, as a pathologist, he sees only advanced cases. Some time ago he had seen another case of Doctor Neuhof's in which there were bacteria in the wall without any thrombus formation within.

GANGLION OF THE PERONEAL NERVE

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Case Report.—R. F., age 15, came to the Surgical Out-Patient Department, April 28, 1936, complaining of a pain in the left leg and of a limp in walking. He stated that the pain had begun two weeks previously and his symptoms, especially his disability on walking, had grown worse. The patient's mother, believing he had rheumatism,

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had massaged his leg vigorously. About six days before coming to the clinic a swelling, which had not been previously observed, was noted at the posterolateral aspect of the leg below the knee. There was no history of trauma obtainable. The patient was a well developed boy of 15 who was not in obvious pain. He walked with a distinct limp of the left leg.

On examination, there was a sausage-shaped mass about 6 cm. long and about 3 cm. in diameter lying obliquely over the head of the fibula and extending upward toward the popliteal space (Fig. 1). The mass was hard, not tender, and apparently fixed to the tissues. There was a slight weakness of the peroneal muscle group and a parasthesia in the sensory distribution of the peroneal nerve. A tentative diagnosis of ganglion pressing on the peroneal nerve was made.

FIG. 1.—Ganglion of peroneal nerve.

FIG. 2.—Drawing made at operation showing trilocular ganglion of the peroneal nerve. Note compression of nerve trunk along under surface.

Operation.—Under local infiltration anesthesia with 1 per cent novocain solution, the tumor mass was exposed following incision of the deep fascia. After blunt dissection, a trilocular mass was isolated and elevated on the finger (Fig. 2). It was found to be continuous with the peroneal nerve, the body of which had been compressed to a flat ribbon-like mass along its lateral aspect. The sac was opened and considerable gelatinous material escaped. It was carefully dissected away from the nerve trunk, during which procedure traction on the sac caused a radiation of pain down the lateral aspect of the lower leg. After removing the ganglion sac as carefully as possible, without damaging the nerve, the wound was closed with interrupted sutures of silk. Lateral plaster splints were applied over the dressing to hold the foot in right-angled extension. The patient was provided with crutches and permitted to go home.

The postoperative course was uneventful. His sutures were removed on the fifth day and his splint on the twelfth day. At that time he had no discomfort and there were normal strength and sensation in the peroneal distribution. At the present time the wound is well healed and there is no disability in walking. There is no evidence of recurrence of the ganglion.

This case presents several interesting features aside from the unusual situation and symptoms caused by a ganglion. In considering the question as to the etiology of ganglia, it will be recalled that these lesions are commonly found in relation to joints and tendon sheaths. For this reason, they were for a long time believed to be due to a rupture or herniation of a tendon sheath or joint capsule. Several authors suggested that they were benign neoplasms of mesoblastic tissue. Finally, the theory was advanced that ganglia were degeneration cysts in the connective tissue of joint capsules and tendon sheaths.

FIG. 3.—Low power photomicrograph of ganglion of peroneal nerve.

Carp and Stout,[1] in 1928, made a careful study of the pathology of ganglia and concluded that they arose from a "mucinous degeneration of the collagen in the dense connective tissue adjacent to a tendon sheath or the capsule of a joint." King,[2] in 1932, pointed out that, in response to an irritation, connective tissue about a joint undergoes a metaplasia, changing from the normal spindle cells to spheroidal cells. This same change he found to occur in the early stages of ganglion formation. He was able to show that the spheroidal cells, which occur in patches, first form vacuoles of mucinous material which later pass into the intracellular spaces. The spheroidal cells disintegrate, forming small cystic cavities filled with mucin. The walls between these cavities finally disappear, permitting the formation of larger cystic cavities. King looks upon the process not as a degeneration but as the normal response to a stimulus of the specialized connective tissue forming joints and tendon sheaths. He believes ganglia are pseudojoint cavities, so to speak.

In the Surgical Out-Patient Department at the Hospital of the University of Pennsylvania we have had a considerable opportunity to study these lesions. A microscopic study made by Dr. P. M. Mecray, Jr., has confirmed King's observations. Our clinical experience has shown us further that the metaplastic change to the formation of ganglion is not confined alone to the connective tissue of joints and tendon sheaths, but that it may occur in many other connective tissues. We have found ganglia on the forehead, and on the dorsal surface of the distal phalanx of the thumb and great toe, and there is here presented a ganglion arising from the connective tissue of a nerve trunk.

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AN UNUSUAL BLOOD VESSEL INJURY ASSOCIATED WITH DISLOCATION OF THE SHOULDER JOINT

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DISLOCATION of the upper end of the humerus is of frequent occurrence. Its reduction, in the vast majority of instances, presents little difficulty. Complications are so rare that we are prone to forget that they not only do occur but may be quite serious.

Case Report.—Mr. C., age 64, was admitted to the West Baltimore General Hospital, March 6, 1936, with a typical dislocation of the right humerus. An intern reduced it under general anesthesia, without great difficulty and without noting its exact type, though from his description it was probably subglenoid in character.

One month later the patient returned with a similar dislocation and the same intern "reduced" it again. Later in the day the patient stated that the bone had slipped out again. This time the resident surgeon reduced it and the bone remained in place. The following morning, however, the patient returned complaining of great pain in the arm and hand; examination revealed a rather nonsensitive tumor in the axilla about the size of a lemon. Pulsation could be felt in the radial artery. The man was hospitalized.

The following day a roentgenogram showed a normal shoulder joint, with no fracture or other abnormality. The swelling had not increased in size. It was rather firm, but fluctuated. The patient did not know whether it had been there since the first dislocation or not—nor had the intern noted it at the second dislocation. The axillary artery was stretched over it and could both be seen and felt pulsating. No thrill could be felt over the swelling nor could one be heard. Diagnosis was probable hematoma.

The man was treated expectantly for a few days, during which time neither the character nor the size of the tumor changed. The pain and discomfort, however, had

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increased so greatly that one of the staff incised the mass under general anesthesia, and on turning out some old blood clot, encountered a furious hemorrhage of arterial blood. The wound was packed. Pulsation was still felt at the wrist.

One week later, on removing the pack, another violent hemorrhage occurred and the wound was again packed. Pulsation was still felt at the wrist. The following day the vessels of the axilla above and below the shoulder joint, were dissected out under the assumption that a tear had occurred in a major branch, and that, with the vessels secured above and below, the pack could be removed and the site of the injury located and dealt with properly. The only unusual thing encountered during the dissection was a complete tear of one of the large axillary veins, which was ligated above and below. On removing the pack, and in spite of the fact that all vessels were closed off with tapes, the same violent hemorrhage recurred and again the wound had to be packed.

The major pectoral muscle had been severed during the dissection but following the hemorrhage the pectoralis minor was severed as well and the dissection was carried out up to the clavicle. Just below this the axillary artery was found to be bifurcated, with the uppermost branch turning back under the brachial plexus and then coursing straight down toward the shoulder joint. This branch was ligated, but when the pack was removed another hemorrhage occurred, though it was not so furious as the preceding one had been. This gave an opportunity to inspect the axilla for the first time, whereupon it was seen that blood was spurting from several different points high up on the chest and toward the posterior apex of the axilla. The application of five heavy Kocher clamps was necessary in order to check all bleeding effectually. The patient, however, had become practically exsanguinated. A transfusion was immediately given. The axilla was lightly packed around the clamps and the patient was returned to his bed.

There was no further bleeding. The packing was gradually removed and in ten days all clamps had either come off or had been removed. The patient regained his strength and his wound granulated satisfactorily. His radial pulse remained. For a time there was an annoying hyperesthesia, some edema at elbow and limitation of motion at the shoulder joint, which still persists.

It is most unfortunate that more careful observations were not made in the clinic, because, as matters stand, it is impossible to determine whether the injury to the blood vessels occurred at the time of the dislocation or during, and as a result of, the reduction. It could have happened either way. But quite aside from this question there is another which has to do with the exact nature of the complication. Only here, too, it is impossible to give a definite answer. With the radial pulse palpable at all times and with the axillary artery both seen and felt pulsating as it lay stretched over the swelling, one could hardly see how there was any break in continuity of the main artery. Nor could one feel that there was an arterial tear of such character as to give rise to an aneurysm. There was no pulsation in the swelling nor could a thrill be heard or felt.

The most plausible explanation of the whole phenomenon is that given by Dean Lewis, with whom the case was discussed. Doctor Lewis suggested that the man may have had an arteriovenous aneurysm at the time of the original accident, which might have originated from the thyroid axis above and the subscapular vessels below. The dislocation and manipulation during reduction might well have torn certain of the anastomotic vessels, thus giving

rise to the original hematoma and the hemorrhage resulting from removal of the overlying clots. He had seen such an occurrence, and certainly on that basis everything could be explained satisfactorily—and only on that basis. The patient has no evidence of such an aneurysm now but that does not necessarily prove that he did not have one previously, because the severe treatment he received by the application of heavy clamps to the various bleeding points might possibly have effected a cure. One can only say that the explanation offered is both plausible and interesting. The patient's radial pulse, by the way, remains, so it would seem that his main arterial channel has not been affected.

But even if it is impossible to be certain just how the blood vessel injury arose, whether actually at the time of the original dislocation or later at one of the three reductions, and even if the exact nature of the complication cannot be ascertained with absolute certainty, it is nonetheless true that there was a dislocation and there was a serious blood vessel lesion. That is the most important point and it is well to realize that such a complication can occur.

BOOK REVIEW

MEDICAL GREEK AND LATIN AT A GLANCE. By Walter R. Agard, B.Litt., (Oxon.), Professor of Greek, University of Wisconsin. Second Edit., New York, N. Y., Paul B. Hoeber, Inc., 1937.

A careful study of the above brief compendium reveals the fact that it, in no way, aims to be a substitute for the general medical dictionary, but has tabulated, in a very easy assimilable form, the prefixes which are constantly encountered which are, in turn, followed by a consideration of the common suffixes and the general principles for making compounds. It contains, in addition, a comprehensive list of many of the more frequently used medical terms, the derivations of which are analyzed.

To one who has not familiarized himself with, or become interested in, the most absorbing pleasure of the study of philology, the etymology, and dependent upon that, the meaning of many medical terms, must be quite confusing. They are, however, to a very large degree, based upon Greek roots, and their formulation dates back to the Hippocratic period and to the influence of that Greek of Pergamos, Galen. When, however, Greece was conquered by the Romans, practically all of the Greek roots were taken over by them and much transliteration resulted which has caused further confusion.

A consideration of the present volume elucidates many of these apparent incongruities. A critical review, however, of the book demonstrates evidences of this very confusion. Thus one notices, for instance, on page 11 that the Greek k is said to be regularly represented by c although k is sometimes retained, as in leukemia, but the author, on page 41, uses the c instead of the k in his spelling leucocyte. Most medical dictionaries have discarded the c and now use k. A similar criticism is made of the spelling of leucopenia. On page 41, it is also noted that gastroenterostomy has not been hyphenated. Throughout the book, many instances of the retention of the use of diphthongs is continued as in apnœa, diarrhœa, gynæcology.

On page 43, the use of the term "pyopneumopericardium" is noted. This is felt, by the reviewer, to be an incorrect compound as the author quotes the Greek derivation, *i.e.*, πνεῦμα (pneuma) air. This is the nominative case which should not be used in making a compound, but more correctly the root, which is πνευματ, the genitive being πνεύματος (pneumatos). Would not "pyopneumatopericardium," therefore, be a more correct usage?

Similar changes should be made in the spelling of the following frequently used compounds, *i.e.*, pneumothorax to pneumatothorax, and pneumoperitoneum to pneumatoperitoneum. Here pneumato might possibly be elided to pneuma, but pneumo can not be justified under any circumstances.

On page 47 is to be noted the use of the word appendectomy. On examining this, one notes that, although it is an almost universally used word, it is, in reality, no word at all and should be spelled appendicectomy. In this same connection, a similar term, which is entirely incorrect, namely, pneumectomy, is quite frequently used by authors. Analysis of it would show that if it were to be considered any word at all, its literal definition would be cutting out of air; what is really desired is the use of the word pneumonectomy, meaning the excision of lung, the root being pneumon (lung).

It is felt that the inclusion of such words as uranalysis and urinalysis, with their proper derivations and definitions, would be worth while, as the latter, although the more generally used term, on analysis indicates that it denotes exactly the opposite of that which the writer means to convey, alysis and analysis denoting two entirely different procedures.

Another most interesting compound to be noted on page 57, *i.e.*, the use of the terms hematogenic and hemolysis. The word for blood is αἷμα. The root is αἱματ. Just what justification there is for changing the terminal vowel from an a to an o is not clear. The compound should be spelled hematolysis and not hemolysis. It is feared that the words denoting blood, where hemo has been used, are the result of following previous dictionaries in which similar terms are to be found, but which are themselves in error for not having studied out the correct philologic and etymologic derivation of the compound. The above instance is in direct contradiction to the rules for compounding words as noted on page 39, paragraph 27.

It is, however, only by the publishing of such researches as the present one offered by Professor Agard, that we can ultimately properly revise and standardize medical nomenclature. Certainly these matters are no longer included in the curriculum of our high schools and in some instances, colleges have also eliminated courses in Greek, so it is to be but little wondered at that so many errors occur in our current medical and surgical periodicals, a condition which can be markedly changed for the better or entirely eliminated by reference to this most excellent consideration of the use of proper Latin and Greek terms.

To consider the matter facetiously, it might again be said that: "The Greeks had a word for it." Doctor Bunting, in his Introduction remarks on the almost universal acquirement by the modern medical student of the "small Latin" of a gentleman's education, but is entirely lacking in the "less Greek."

JAMES T. PILCHER.

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